

FINAL
SITE REASSESSMENT SUMMARY LETTER REPORT, REVISION 1
CANADIAN RADIUM & URANIUM CORP.
KISCO AVENUE
VILLAGE OF MOUNT KISCO, WESTCHESTER COUNTY, NEW YORK

EPA ID No. NYD987001468

EPA Contract No.: EP-S8-13-01
W.O. No.: 20408.012.004.0428.00
Document Control No.: W0428.1A.02092

September 2019

Prepared for:

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Prepared by:

Region 2 Site Assessment Team
Weston Solutions, Inc.
Edison, New Jersey 08837

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SUBMITTED BY:



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09/30/2019
Date

Introduction

The United States Environmental Protection Agency (EPA) has tasked Weston Solutions, Inc. (WESTON®) Region 2 Site Assessment Team (SAT) with additional Site Reassessment activities to gather and evaluate new information on the Canadian Radium & Uranium Corp. (CRU) site in the Village of Mount Kisco, Westchester County, New York, and to determine whether further Superfund action is warranted. The Site Reassessment is assigned under EPA Contract EP-S8-13-01 (Region 8 Superfund Technical Assessment and Response Team IV [START IV]). In 2013 and 2014, Region 2 SAT conducted Site Reassessment activities that were focused on the surface water and air migration pathways; the Site Reassessment Report completed at that time and supporting documentation are incorporated here by reference (WESTON, 2014). Since that time, EPA Removal Assessment activities at the site have been conducted to further delineate the extent of contamination at the site and to evaluate on-site groundwater conditions.

The Site Reassessment activities included collection of groundwater samples from off-site water-supply wells in December 2016 and June 2017, analysis of the samples for radiochemistry parameters, validation of the analytical results, evaluation and incorporation of the on-site Removal Assessment data and off-site Site Reassessment data, and re-evaluation of the ground water migration pathway. The work was conducted simultaneously with Removal Assessment activities being conducted by EPA. This Site Reassessment Summary Letter Report provides a description of the CRU site, a discussion of the investigative and remedial actions at the site, results of the Removal Assessment, results of the December 2016 and June 2017 supply-well sampling, and a hazard assessment including a Hazard Ranking System (HRS) site score.

Revision 1: New York State Department of Environmental Conservation (NYSDEC) has alerted EPA to radiological contamination at the location of the former Mount Kisco wastewater treatment plant (WWTP) located approximately 1.5 miles south of the CRU site. During its operational period, CRU discharged wastewater through the public sewer to this WWTP. The main pathways of concern associated with this additional source area are the ground water and surface water migration pathways. Based on these considerations, the contaminated material at the former WWTP location is being evaluated as an additional source of contamination associated with the CRU site, and the groundwater and surface water migration pathways are re-evaluated.

Site Location and Physical Description

The CRU facility recovered uranium and other radioactive elements from uranium-bearing sludge and old instrumentation. The subject property is located to the east of Kisco Avenue and to the west of railroad tracks in the Village of Mount Kisco, Westchester County, New York, in an area that is primarily suburban residential and commercial. The current properties where CRU operated historically (i.e., “the subject property”), 103 and 105 Kisco Avenue from south to north with Railroad Avenue between, total 2.72 acres and are currently occupied by a landscaping business (103 Kisco Avenue) and a stone, masonry, and landscaping business (105 Kisco Avenue). The subject property is bounded by Kisco Avenue to the west, southwest, and northwest; railroad tracks to the south, east, and northeast; and a large, privately-owned warehouse to the north-northeast. The site location is shown in **Figure 1**.

The 103 Kisco Avenue property is partially paved and completely fenced with an access gate, which is closed and locked when employees are not on site. There is one small work trailer located at the

northernmost portion of the property; the trailer includes a reception area, office, and employee break room. The property is used for parking trucks, forklifts, and other heavy machinery, and for staging roll-offs filled with debris and materials. Cement corrals for materials are also located on-site. Many areas are inaccessible for survey or sample collection activities due to the presence of obstructions such as wood piles, heavy machinery, and roll-offs. A manhole is located at the northeastern corner of the site.

At the 105 Kisco Avenue property, buildings, which were not part of the original CRU facility, consist of a main building for office and retail activities in the west-southwestern portion of the property and two warehouses in the northeastern portion of the property. There is a paved parking area for customers in the southwestern portion of the property. The rear, eastern portion of the property is used for storage of surplus materials in corrals, separating different materials such as gravel, sand, wood chips, and other supplies. Materials and heavy machinery are present throughout the property.

Site History

From 1943 until sometime prior to 1966, the CRU facility operations in Mount Kisco included the recovery of uranium and other radioactive elements from uranium-bearing sludge, old instrumentation, and watch dials. The work began as part of the federal government's Manhattan Project. From 1943 to the 1950s, the primary product was uranium recovered from uranium-bearing sludge; subsequently, radium recovered from instruments and watch dials became the principal product until the facility's closure. New York State Department of Health (NYSDOH) has reported that the CRU facility also recovered radium-D (i.e., lead-210 [Pb-210]), radon, polonium, and actinium. In 1957, the plant manager died of leukemia and CRU pled guilty to charges of allowing three employees to be overexposed to radiation. Between March 1958 and sometime after May 1961, decontamination and disposal procedures were established for the CRU facility.

In November and December 1966, the facility buildings (a two-story concrete block building and two smaller one-story concrete block buildings) were decontaminated and demolished as part of urban renewal efforts in the area. In addition, radioactive surface soil was excavated for disposal. A post-operation survey conducted by Isotopes, Inc. identified two locations on the Haggerty Millwork wall, originally shared with the main CRU building that had been demolished, above specifications. One contaminated location was removed by chiseling out the masonry of the wall. The second was a result of tailings from a leaking waste drum, which CRU had apparently stored on the second floor fire escape; since contamination was relatively low and it was a load-bearing section, the area was sealed with 1 to 2 inches of mortar until radiation levels were considered acceptable. The waste material showing the highest radiation levels was identified during the decontamination activities and collected into a drum. The drum was removed from the site by Nuclear Diagnostic Laboratories of Peekskill, New York, for disposal at the West Valley low-level radioactive waste burial site. All other waste material was monitored, loaded, and hauled off-site for disposal in the Croton Point Sanitary Landfill in Croton-on-Hudson, New York.

According to the demolition and decontamination report, the Haggerty Millwork building was scheduled for demolition within a year after the demolition of the CRU buildings. Sanborn Maps and aerial photography show that, by 1971, the Haggerty Millwork building had been demolished

and the newly-paved Railroad Avenue had been relocated to where the main CRU building once stood. The maps and aerial photography also show that there were no structures remaining on the 103 Kisco Avenue property, and that new buildings had been constructed on the 105 Kisco Avenue property and the facility was operating as a lumber yard.

Previous Investigations (1979-1998)

In April 1979, Westchester County Health Department (WCHD) performed a radiological survey at the site. Based on the survey, the highest dose rates (i.e., 0.35 to 0.42 millirem per hour [mrem/hr], compared to the background level of 0.015 mrem/hr) were found in a small portion of a fenced area east of the lumber yard (i.e., an area located adjacent to the railroad). All other elevated dose rates were found in areas covered by soil and vegetative growth. A February 1980 memorandum described the WCHD investigation findings in more detail. The area in question was approximately 78 feet by 60 feet, enclosed by a chain-link fence, and located between the railroad tracks and a concrete-covered area. The most significant contaminated area was a strip 15 feet by 5 feet, containing two separate "hot spots". Elevated readings several times above background were reported for an area extending about 50 feet south from the chain-link fence. The memorandum stated that the origin of this contamination was unknown and that it had not been discovered in previous surveys.

In September 1993, the Bureau of Environmental Radiation Protection of the New York State Department of Health (NYSDOH) completed a survey of the CRU site. Indoor radon measurements collected in the office, showroom, and storage/sales floor area documented a maximum value of 9.8 picocuries per liter (pCi/L) and an average value of about 8.1 pCi/L. NYSDOH also identified two outdoor areas where presence of radioactive materials was indicated: 1) the back portion of 105 Kisco Avenue, and 2) the road that ran next to the railroad tracks and inside the fenced portion of 103 Kisco Avenue.

In 1994, an EPA Site Inspection (SI) was conducted at the site to measure radon levels, collect air and soil samples, and measure exposure rates. Elevated exposure rate measurements were observed on both the northern (10–700 microroentgens per hour [μ R/hr]) and southern (10–240 μ R/hr) portions of the site property. Radium-226 (Ra-226) concentrations in soil samples taken from the top 1.5 feet ranged from 3 to 150 picocuries per gram (pCi/g). All of the radon measurements were below EPA's guideline (i.e., 4 pCi/L) and the air samples collected at the site did not detect any suspension of radioactive contamination.

In July 1998, NYSDEC completed a radiological survey of the site properties. The 103 Kisco Avenue property was found to have contamination over one large unpaved area (about 4,000 to 5,000 ft²) and a few smaller areas. The highest radium concentrations observed were a few hundred pCi/g and in the top foot of soil. Soil sampling completed near Railroad Avenue, where the CRU facility once stood, showed elevated radium a few feet below the surface. Sampling beneath the road surface was not performed. There was no documentation of shielding or other control measures implemented on the property, but the conditions suggested that the property had been recently paved with asphalt or other cover materials.

The survey of the 105 Kisco Avenue property indicated that radioactive materials were present under the parking lot, but no samples were taken beneath the asphalt. The highest concentration of radium at the site (about 6,000 pCi/g) was found just north of Railroad Avenue. A large part of the main outside storage area was reported to be contaminated with radium near the surface as well as within some soil profiles to depths of about 4 feet. Railroad Avenue showed count rates that were lower than background soils; NYSDEC attributed these results to shielding by the road surface material. NYSDEC reported that radiation doses to workers or visitors to the site as it was used at the time were not significant. The dose rate was highest in a small area just north of Railroad Avenue; the accumulated dose in this area was estimated to be small due to expected short exposure times. NYSDEC did not consider the site to be fully characterized at the completion of the survey.

Previous Site Reassessment Sampling (2013-2014)

In September 2013, Region 2 SAT performed an on-site reconnaissance and gamma survey of the former CRU property and other possible areas of contamination. Background readings taken north and northeast of the site in the right-of-way (ROW) area alongside Kisco Avenue showed background gamma radiation levels of approximately 7,500 counts per minute (cpm). There were three areas in the back portion of the 105 Kisco Avenue property, east of the historical CRU main building, where readings exceeded two times (2x) background. Region 2 SAT performed gamma screening the sheds and warehouses, but not inside the main building. There were no elevated readings on the 103 Kisco Avenue property, including the manhole at the northeastern corner of the property. Many areas on both properties were inaccessible for screening due to obstructions (e.g., piles, heavy machinery, roll-offs). Gamma screenings of Railroad Avenue and the ROW area bordering Railroad Avenue showed gamma readings ranging from background to 30,000 cpm, with the highest reading at the corner of the 105 Kisco Avenue property.

In November 2013, Region 2 SAT advanced eight boreholes to the depth of 10 feet at the site for gamma screening and soil sample collection. Gamma screening data was collected with a scintillation meter at 6-inch depth intervals vertically down each borehole, and soil samples were collected from the intervals within each borehole where the highest gamma levels were recorded. The samples were analyzed for gamma-emitting radioisotopes including Ra-226 and Ra-228, isotopic thorium, isotopic uranium, and Target Analyte List (TAL) metals including mercury.

Analytical results for the soil samples indicated that levels of uranium-238 (U-238) and U-234 were at background levels (0.4–0.8 pCi/g), whereas several samples exhibited significantly elevated levels of thorium-230 (Th-230) (4.6–83.3 pCi/g) and Ra-226 (15.4–135 pCi/g). All instances of elevated Th-230 levels correlated with elevated Ra-226 levels. The lack of equilibrium between the parent radioisotopes (i.e., U-238, U-234) and daughter radioisotopes (i.e., Th-230 and Ra-226) of the U-238 decay series suggests that the measurable residual contamination at the CRU site is from processed material (i.e., material from which uranium has been extracted) and not from uranium ore. All individual radioisotope levels for the Th-232 decay series (i.e., Th-232, Th-228, and Ra-228) were at background levels (0.6–1.2 pCi/g) and were observed to be in equilibrium in each sample. There was one sample location that exhibited greater than three times (3x) the highest background level of lead, and mercury concentrations exceeded 3x background at three locations.

During the November 2013 sampling event, Region 2 SAT collected air measurements with RAD7 radon/thoron detectors at potential source areas, downwind locations, and background locations upwind (north) of the site. The sample inlets were set 1 meter above the ground surface. Radon and thoron were measured hourly for one 4-hour period in the morning and one 3-hour period in the afternoon. There were no levels of radon that met the criterion for significance above background (i.e., 2 standard deviations [2σ] above the site-specific background level). One downwind thoron measurement met the criterion for significance above background; however, this elevated thoron concentration was not considered to be site-attributable because thoron is part of the Th-232 decay series that was shown to be at background levels and in equilibrium on the site. There were no other significant levels of thoron documented.

In May 2014, Region 2 SAT personnel collected six sediment samples (including one environmental duplicate sample) from five locations along the perennial drainage ditch and Kisco River Tributary 8 located east and downstream of the site. One background sample was collected upstream from the probable point of entry (PPE) and another background sample was collected from the tributary upstream of the confluence with the perennial drainage ditch. Analytical results show that there is an observed release of Ra-226, Pb-210, and elemental lead from the CRU site to the surface water pathway. Three samples from two locations in the perennial drainage ditch, including the PPE, exhibited concentrations of elemental lead that were greater than 3x the maximum background level. One of the locations also exhibited levels of Ra-226 and Pb-210 that were 2σ above the mean site-specific background levels. To evaluate attribution of the observed release to the site, the percentages of isotopic lead (Pb-204, Pb-206, Pb-207, and Pb-208) found at the sediment sample locations were compared to average natural abundances. Pb-206, an end product of Th-230 and Ra-226 decay, was slightly elevated (about 1.25–1.75%), whereas Pb-204, Pb-207, and Pb-208 were slightly depressed for all samples including background. The highest Pb-206 percentages were at locations closest to the site. The slightly elevated abundance of Pb-206 suggests that the observed release is at least partially attributable to the CRU site.

Removal Assessment (2015-2016)

In August 2015, EPA Region 2 Removal Branch and WESTON's Removal Support Team 3 (RST 3) began a Removal Assessment at the site, the adjacent railroad right-of-way (Metropolitan Transit Authority [MTA] milepost 136), and a background location (a strip mall at 145-159 Kisco Avenue). EPA and RST 3 conducted gamma surveys of occupied indoor spaces, outdoor areas, and soil sample locations; screening for specific radioisotopes with a portable radioisotope identification system; a survey with RAD7 radon/thoron detectors; radon sampling in occupied spaces of on-site properties; and soil sampling.

The gamma surveys showed above-background gamma readings in many areas of the site, including indoor spaces at 105 Kisco Avenue (i.e., the electrical room of the main building and the southeastern corner of Warehouse 2), outdoor areas, and soil sample locations. The highest readings (140,000 to 180,000 cpm) were observed at a soil sample location near the northwestern corner of Warehouse 2, and there were readings of 80,000 to 120,000 cpm at an area where bagged soil was being staged on the ground surface at 103 Kisco Avenue. According to the property tenant at the time, the bagged soils were from a previous 3-foot-deep trench for installation of an electrical line across Railroad Avenue (i.e., where the CRU main building once stood). Under EPA's

recommendation, the tenant subsequently restaged the bagged soil into a portable storage container. The specific radioisotope survey identified Ra-226 in some areas, including near the bagged soil and in jarred soil samples from both properties. Radon and thoron were detected above background levels at nine of thirteen surveyed locations inside the 105 Kisco Avenue main building.

Radon sampling in regularly-occupied spaces of on-site buildings by a National Radon Proficiency Program (NRPP)-certified company showed concentrations as high as 19.5 pCi/L in the 105 Kisco Avenue main building, compared with the EPA Site-Specific Action Level (SSAL) of 4 pCi/L, as well as slightly elevated concentrations in the southeastern corner of Warehouse 2. All other locations showed normal radon levels below the EPA SSAL. A radon mitigation system was installed in the main building and, in October 2015, a post-remedial radon sampling event indicated normal levels of radon below the EPA SSAL for all radon canisters deployed in the main building.

The soil sampling activities included collection of 12 soil samples (including one field duplicate) at the site using direct-push technology and one soil sample from an expected background location using a posthole digger and shovel. Locations exhibiting elevated radioactivity (as previously measured) were selected for soil sampling. The soil samples were analyzed for TAL metals and mercury; isotopic thorium and isotopic uranium; and Ra-226 (21-day ingrowth), Ra-228, and other gamma-emitting radioisotopes. The radioisotope analytical results were compared with EPA SSALs, and the analytical results for TAL metals and mercury were compared with EPA Removal Management Levels (RMLs). Ra-226 was detected above its EPA SSAL (2.52 pCi/g) at seven soil sample locations, with the highest reading (an estimated 129 pCi/g) detected in a sample from a depth of 0 to 2 feet below ground surface (bgs) at 105 Kisco Avenue. No radioisotopes were detected above the EPA SSAL in soil samples collected from the background location.

During the August 2015 Removal Assessment event, EPA collected seven on-site wipe samples from locations biased toward floor cracks and entryways and one field blank wipe sample. The wipe samples were analyzed by EPA's Radiation Health Physicist (RHP) for the presence of radioactivity using a Ludlum-3030 meter. Alpha and beta counts for all the wipe samples were at the natural background level conservatively estimated by counting a blank wipe.

In April 2016, RST 3 and EPA conducted Removal Assessment Phase II, which included additional ground radiological surveys, as well as direct-push soil sampling at 19 locations throughout the site and at a new off-site background location, 123-135 Kisco Avenue. The radiological survey and soil sampling event was conducted to identify additional source areas and to assist in determining the extent of on-site radioactive contamination. The radiological survey was hindered by parked vehicles and supplies in outside storage areas at 103 Kisco Avenue and by the presence of large quantities of merchandise in outside storage areas throughout 105 Kisco Avenue (particularly the northeastern portion of the property). The radiological survey showed several on-site locations with gamma readings exceeding 2x background. At 103 Kisco Avenue, there were elevated gamma readings along the northeastern fence line (near the staging location of the bagged soil), along ROW areas to the northwest and north, and at the southern portion of Railroad Avenue. At 105 Kisco Avenue, elevated gamma readings were observed in the vicinity of Warehouse 2, in the northwestern portion of the property between merchandise storage areas, near the southern access gate next to the customer parking lot, at the southeastern corner of the perimeter fence, in the center of the customer parking lot, and near the western entrance to the main building.

During the April 2016 event, EPA used surface gamma screening results to select boring locations for soil sample collection; four on-site locations with elevated gamma readings, fifteen on-site locations with background gamma readings, and the off-site background location were selected. A drilling subcontractor advanced the borings and extracted soil cores to depths 4 to 8 feet bgs at the sampling locations, and RST 3 collected soil samples from every 12-inch interval of each core. Upon completion of each borehole and prior to backfilling, RST 3 conducted gamma screening at 6-inch intervals vertically down to the bottom of the hole; this subsurface borehole screening was conducted to determine the depth intervals with the highest gamma reading and to vertically delineate the extent of the radiological contamination.

RST 3 collected a total of 96 soil samples (including four field duplicates) from the 19 on-site soil borings, and seven soil samples (including one field duplicate) from the off-site background soil boring. The soil samples were split between two laboratories for analysis, Pace Analytical Services (PACE) and EPA's National Analytical Radiation Environmental Laboratory (NAREL); all the soil samples were analyzed for isotopic thorium, isotopic uranium, Ra-226 (21-day ingrowth), Ra-228, and other gamma-emitting radioisotopes. Ra-226 was detected above the SSAL (2.52 pCi/g) in at least one 12-inch interval at all but two on-site locations and at the presumed background location. The on-site exceedances ranged from 2.57 pCi/g to 926.1 pCi/g, with the highest level in the 36- to 48-inch depth interval along the northern edge of Railroad Avenue; Pb-210 was detected above the EPA SSAL of 418 pCi/g in the same sample. Two locations, both located in the south-southeastern portion of 105 Kisco Avenue, showed Ra-226 exceedances in the 0- to 12-inch depth interval, and on-site exceedances extended as deep as 84 inches bgs. The off-site Ra-226 levels ranged from 0.61 pCi/g to 11.04 pCi/g, with the lowest level in the 72- to 84-inch depth interval and the highest level just beneath that in the 84- to 96-inch depth interval. Of the four on-site locations sampled beyond 48 inches bgs, none showed a Ra-226 exceedance in the 84- to 96-inch depth interval.

In June 2016, EPA and the Department of Energy (DOE) independently conducted aerial overflights of the site to determine the possibility of lateral spread of the radiation contamination. The DOE overflight indicated potential lateral spread to the west of the Site along Kisco Avenue. The EPA overflight indicated two other potential areas of interest, one located immediately southeast of the site at North Moger Avenue and the second located approximately 0.5 mile southwest of the site in the parking lot of Diplomat Towers (a residential condominium complex).

In December 2016, EPA and RST 3 conducted Removal Assessment Phase III, which included ground surface gamma screening at the potential areas of interest identified by the June 2016 aerial overflights. The gamma readings in these areas all were below 2x background. Phase III also included drilling and installation of three temporary wells at 105 Kisco Avenue. Groundwater was encountered at depths of approximately 4 feet bgs in all three temporary wells; groundwater elevations indicate that groundwater in the water-table aquifer flows north-northeast across the site, approximating the paths of Kisco Avenue to the west, the railroad tracks to the east, and Kisco River further east. The groundwater elevations show that the Phase II off-site location, where there is clean soil above contaminated soil and the contamination is below the water table, is hydraulically downgradient of the contaminated soil source at the site. This suggests that the Ra-226 contamination might have migrated to the off-site location via subsurface flow.

Groundwater samples were collected from the temporary wells and analyzed by PACE for the same parameters as the Phase II soil samples, plus gross alpha and gross beta. Duplicate samples TW-3-

01 and TW-3-02 were collected from the location along the north side of Railroad Avenue that showed the highest soil levels of Ra-226 during Phase II. Sample TW-1-01 was collected in the northern portion of the site, downgradient of that soil hotspot. Sample TW-2-01, collected along the eastern edge of the property from an area that showed lower relative Ra-226 soil concentrations and in a sidegradient position, is evaluated as a background sample. The Ra-226 levels in samples TW-3-01 (45.8 pCi/L), TW-3-02 (315 pCi/L), and TW-1-01 (7.18 pCi/L) were significantly above the background level detected in sample TW-2-01 (estimated 0.92 pCi/L), constituting an observed release to on-site groundwater of a site-attributable contaminant.

Site Reassessment Water-Supply-Well Sampling

For the current Site Reassessment, Region 2 SAT conducted two rounds of groundwater sampling (December 2016 and June 2017) consisting of samples from six nearby water-supply wells, as described below. All six wells actively serve residential or worker populations and all were in operation during both sampling events. The sampling efforts were conducted in support of the Canadian Radium & Uranium Corp. Site Reassessment assigned under EPA Contract EP-S8-13-01 (Region 8 START IV).

December 2016: On December 6, 2016, Region 2 SAT personnel collected a total of seven aqueous groundwater samples (including one environmental field duplicate) from six active water-supply wells located within or just beyond a 1-mile radius of the CRU site. Region 2 SAT collected the samples from two wells that serve a subdivision northwest of the site (sample 0428-WSW01 and duplicate samples 0428-WSW02/0428-WSW06); two wells that serve an apartment complex northeast of the site (samples 0428-WSW03 and 0428-WSW04); and two wells that serve professional buildings southeast of the site (samples 0428-WSW05 and 0428-WSW07).

The wells were purged for at least 15 minutes before sampling; two wells that had water holding tanks prior to sampling spigots (i.e., sample locations 0428-WSW05 and 0428-WSW07) each were purged for more than 30 minutes before sampling. Additionally, water quality was monitored during the purges at each well with a multiparameter water-quality meter, to confirm stable conditions. After purging at each well, raw groundwater samples (i.e., prior to water treatment) were collected directly into sample containers from the sampling spigots closest to the wellhead. Region 2 SAT also collected one sample with additional volume for laboratory Quality Assurance/Quality Control (QA/QC) purposes. Region 2 SAT logged sample locations electronically using Global Positioning System (GPS) equipment and performed post-processing differential correction of the GPS data. Sample location information is presented in **Table 1** and sample locations are shown in **Figures 2, 2A, 2B, and 2C**.

The December 2016 water-supply-well samples were shipped via FedEx to the NAREL laboratory in Montgomery, AL, where radiochemistry analyses were performed according to laboratory-specific analytical methods as shown in the table below:

Method SOP	Revision / Effective Date	Parameters Reported
AM/SOP-3: NAREL SOP for Gamma-Ray Spectrometry (GAM-01)	Revision 6 / April 26, 2016	Bismuth-212 (Bi-212) Bismuth-214 (Bi-214) Cesium-137 (Cs-137) Lead-210 (Pb-210) Lead-212 (Pb-212) Lead-214 (Pb-214) Potassium-40 (K-40) Radium-228 (Ra-228) Thallium-208 (Tl-208) Thorium-234 (Th-234)
AM/SOP-14: NAREL SOP for Radium-226 Analysis by Eichrom (RA226-EICHROM)	Revision 2 / April 4, 2016	Radium-226 (Ra-226)
AM/SOP-1: NAREL SOP for Actinides in Environmental Matrices by Extraction Chromatography (TH-EICHROM and U-EICHROM)	Revision 8 / November 30, 2016	Thorium-227 (Th-227) Thorium-228 (Th-228) Thorium-230 (Th-230) Thorium-232 (Th-232) Uranium-234 (U-234) Uranium-235 (U-235) Uranium-238 (U-238)
AM/SOP-4: NAREL SOP for Gross Alpha and Beta Analysis of Water Samples (GR-01)	Revision 6 / May 28, 2015	Gross Alpha Gross Beta

Complete sample analytical results for the December 2016 water-supply-well sampling effort are presented in **Table 2**. The results for samples 0428-WSW03 and 0428-WSW04 are considered to represent background levels because they were collected in a sidegradient direction from the site at a farther distance than other samples. For radionuclides that are attributable to a site but also occur naturally, including Ra-226 and other site-related contaminants, the criteria for establishing an observed release by chemical analysis are:

- The result exceeds the minimum detectable concentration (MDC); and
- The result equals or exceeds a value 2σ above the mean site-specific background concentration.

The December 2016 analytical results suggested the possibility of an observed release to two of the sampled target wells. The Ra-226 concentrations in samples 0428-WSW01 (1.07 J [estimated] pCi/L) and 0428-WSW02 (1.14 J pCi/L) exhibited elevated concentrations compared to the mean site-specific background plus 2σ value (i.e., 0.88 pCi/L). The reported levels of gross beta in samples 0428-WSW01 and 0428-WSW02 and the estimated levels of Bi-214 and Pb-214 (daughter products of Ra-226) in sample 0428-WSW01 were also elevated above background. Based on results from previous investigations, Ra-226 is attributable to the site; in turn, its daughter products Bi-214 and Pb-214 are also considered to be site-attributable.

The reported levels of U-234 and U-238 in samples 0428-WSW02, field duplicate 0428-WSW06, 0428-WSW-05, and 0428-WSW-07 appeared to be elevated above background; however, U-234 and U-238 have not been detected significantly above background in on-site soil or groundwater samples and are not considered to be site-attributable. All analytical results reported for the thorium-232 decay series (Th-232, Th-228, Ra-228, and Pb-212) did not meet the criteria for significance above background levels and are therefore considered to be at background levels.

As indicated above and in **Table 2**, the Ra-226, Bi-214, and Pb-214 results that suggest a possible site-attributable release were considered to be estimated values. In addition, radiochemistry results are reported with associated levels of uncertainty. Although the December 2016 results suggested a possible observed release to nearby target wells, none of the results was high enough to overwhelm the associated uncertainty. Therefore, EPA decided to collect confirmatory samples from the wells in June 2017 to re-evaluate the observed release, as discussed below.

June 2017: On June 27 and 28, 2017, Region 2 SAT personnel collected confirmatory samples from the same water supply wells that had been sampled in December 2016. Each sample number was designated with a “-2” suffix to indicate Phase 2 sampling (i.e., resampling) at these locations. Region 2 SAT collected a total of seven water supply well samples (including one environmental field duplicate) using the same well purging and sampling procedures as in December 2016. Region 2 SAT also collected one sample with additional volume (i.e., 0428-WSW07-2) for QA/QC purposes. The samples were shipped via FedEx to the PACE laboratory in Greensburg, PA, where radiochemistry and total potassium analyses were performed according to standard analytical methods as shown in the table below:

Method and Description	Parameters Reported
EPA 200.7 Metals, Total	Total Potassium
SM7500RnB-07 Radon	Radon
EPA 900.0 Gross Alpha/Beta	Gross Alpha Gross Beta
EPA 903.1 Radium-226	Radium-226 (Ra-226)
EPA 904.0 Radium-228	Radium-228 (Ra-228)
ASTM Method D5174-97 Total Uranium KPA	Total Uranium
HSL-300(AS) Actinides	Uranium-234 (U-234) Uranium-235 (U-235) Uranium-238 (U-238)

Complete sample analytical results for the June 2017 Phase 2 water-supply-well sampling effort are presented in **Table 3**. For the Phase 2 results, observed release is evaluated according to the same criteria and background locations as the previous results; therefore, samples 0428-WSW03-2 and 0428-WSW04-2 are considered to represent background levels.

The Phase 2 sampling results indicate that no observed release of site contaminants to target wells has occurred. The only parameter reported at a level elevated above background for sample locations 0428-WSW01 and 0428-WSW02 was U-238 in sample 0428-WSW01-2; however, U-238 is not considered to be site-attributable. For samples 0428-WSW05-2 and 0428-WSW07-2, several parameters were reported above background: total uranium, U-234, U-238, and radon in both

samples, as well as total potassium, Ra-228, gross alpha, and gross beta in sample 0428-WSW05-2. The elevated concentrations at those wells are not considered to be site-attributable because they are not known to be source contaminants and the wells are not located downgradient of the site. The elevated levels of uranium isotopes shown by both rounds of sampling are believed to be naturally-occurring – despite the history of uranium processing at the CRU site, on-site soil and groundwater sampling has not identified uranium or uranium isotopes as contaminants of concern. The elevated radon in samples 0428-WSW05-2 and 0428-WSW07-2 is evaluated as a naturally-occurring daughter product of the uranium isotopes that are present. There were no exceedances of maximum contaminant levels (MCL) during either round of sampling.

Revision 1: Discovery of Radiological Waste Source Material at Former WWTP

On August 21 and 22, 2017, Great Lakes Environmental & Safety Consultants, Inc. (Great Lakes) performed a radiological survey and sampling at 2 Morgan Drive, a property that was previously part of the former Mount Kisco WWTP. In-ground structural components of the WWTP remain at the property, including filter beds, sludge drying beds, ponds (sand filters), primary and secondary clarifier tanks, and sprinkling filter beds. Great Lakes performed a walkover survey with a calibrated field measurement instrument (i.e., Ludlum 2221 ratemeter equipped with Model 44-10 2"x2" sodium iodide scintillation detector) at the property to detect the presence of gamma-emitting radionuclides. Background levels for the gamma walkover survey of 7,000 to 8,000 cpm were recorded in areas not impacted by the site. The walkover survey identified three hotspots near the ponds, clarifier tanks, and sprinkling filter beds with gamma readings of 134,000 cpm, 137,000 cpm, and 180,000 cpm. Some areas of the property were deemed inaccessible due to vegetation overgrowth at the time of the survey.

Great Lakes collected solid-matrix samples from the three hotspots at 2 Morgan Drive, as well as from two sludge drying beds and two ponds. The samples were analyzed for Gross Alpha, Gross Beta, Ra-226, and Ra-228. The analytical results indicated the presence of Ra-226 at levels exceeding the soil cleanup threshold of 7 pCi/g at all three hotspots (25.526 pCi/g to 65.038 pCi/g), in the sludge drying beds (7.768 pCi/g to 14.426 pCi/g), and in Pond #2 (18.709 pCi/g to 21.046 pCi/g). Great Lakes also collected aqueous samples from the ponds. The analytical results for Pond #1 indicated the presence of gross alpha (317 pCi/L) and Ra-226 (11.3 pCi/L) at levels exceeding threshold values (15 pCi/L and 3 pCi/L, respectively) found in NYSDEC Division of Water Technical and Operational Guidance Series (TOGS) Section 1.1.1, *Ambient Water Quality Standards and Guidance Values and Groundwater Effluent Limitations*.

On December 20, 2017, NYSDEC performed a gamma survey at 2 Morgan Drive and the adjacent undeveloped parcel, 6 Morgan Drive, which is also part of the former WWTP property. NYSDEC used the same survey equipment as the previous investigation (i.e., Ludlum 2221 ratemeter with Model 44-10 sodium iodide scintillation detector). Differing physical appearance of the soil on the two properties was attributed to recent soil movement and surface grooming at 6 Morgan Drive. NYSDEC recorded elevated readings ranging from 25,000 to 135,001 cpm at and near the previously-identified hotspot areas, including a waist-high reading of 35,000 cpm, compared to site background readings of 8,500 to 9,500 cpm. The investigation included a gamma walkover survey of approximately half of the Pond #2 bottom, which was exposed and dry at the time and which showed readings ranging from 19,000 to 26,000 cpm.

Survey results on the 6 Morgan Drive parcel included gamma readings of 25,000 to 50,175 cpm at the base of a heavily overgrown soil pile reported to consist of original site soils, readings of 20,000 to 25,000 cpm in the historic sludge spoil storage area, and a hotspot of 223,779 cpm in the bermed area referred to as the Stormwater Retention Area (this area was dry at the time of the survey, but showed evidence of water movement throughout). NYSDEC used gamma spec analyzers identiFINDER R200 (IDF2) and ORTEC Detective X (ORTEC) to identify the isotopic composition of the radioactive material, and confirmed the isotope of concern on both parcels as Ra-226. The IDF2 also measured dose rates of 157 $\mu\text{R/hr}$ at the ground surface in the Stormwater Retention Area and 19 $\mu\text{R/hr}$ at waist height between the Primary Tank and Sprinkling Filter Bed.

Current Hazard Assessment

Based on the background information regarding site history and conditions, as well as results of the Site Reassessment and Removal Assessment investigations, residual contamination is known to exist in subsurface soils at the site. Observed releases are documented in the ground water and surface water migration pathways, but actual contamination is not documented for targets in either pathway.

Sources

The previous site reassessment sampling and the ongoing Removal Assessment show that there is a contaminated soil source at the site. The site was historically a uranium and radium extraction facility functioning from 1943 until sometime prior to 1966. Until the 1950s, the facility's main product was uranium recovered from uranium-bearing sludge. From the 1950s until closure, the main product was radium recovered from instruments and watch dials. It has been reported that lead-210, radon, polonium, and actinium were also recovered at the facility.

As described previously, the CRU facility buildings were decontaminated and demolished in the 1960s, some radioactive surface soil to a depth of 1 foot was excavated during the demolition, and the radioactive waste materials were removed from the site for disposal. Significant physical changes to the subject property, including the relocation and construction of Railroad Avenue where the main CRU building once stood and the construction of new buildings, occurred between 1966 and 1971. Several investigations since 1979 have indicated the presence of residual contamination at the site. As described previously, the radiation surveys and soil sampling completed by Region 2 SAT and RST 3 confirm the presence of residual contamination.

The hazardous substances detected in the contaminated soil source and attributable to historical operations include Th-230, Ra-226, and Pb-210; these radioisotopes are all part of the U-238 decay series. The uranium isotopes in that decay series (U-238 and U-234) have not been detected at elevated concentrations in the contaminated soil, suggesting that the measureable residual contamination is from processed material and not from uranium ore. The contaminated soil is present at or near the ground surface in some locations, and extends to depths as great as 7 feet bgs. The total volume of contaminated soil is unknown.

Revision 1: The Great Lakes and NYSDEC gamma survey and sampling efforts document the presence of a contaminated soil source at the WWTP property. The soil analytical results document a contaminated soil source containing Ra-226 in several areas of the property, and the waist-high gamma readings greater than two times background seem to confirm that there is an area of observed contamination. The depth and volume of contaminated soil at the WWTP location are unknown.

Ground Water Migration Pathway

As described previously, groundwater samples collected during the Removal Assessment activities indicate an on-site observed release to shallow groundwater. However, the Site Reassessment sampling results do not confirm an observed release to nearby water-supply-wells (see **Site Reassessment Water-Supply-Well Sampling**), and there is not documented actual contamination of any target wells.

The aquifer being evaluated consists of the hydraulically-interconnected unconsolidated and bedrock units that underlie the CRU site. The site is underlain by unconsolidated sands and gravels of glacial outwash origin. The glacial deposits lie within a northeast-southwest trending valley defined by a syncline in the underlying bedrock, with the centerline of the valley roughly coinciding with the axis of the syncline. The bedrock consists of a narrow band of Manhattan Schist beneath the valley, but the valley walls and surrounding uplands are underlain almost entirely by Fordham Gneiss, the predominant bedrock unit within the target distance limit (TDL). The CRU site itself is underlain by Fordham Gneiss at the edge of the contact with Manhattan Schist. The bedrock contains water-bearing fractures; the most extensive bedrock fracturing occurs in the first 100 to 150 feet bgs. There are numerous bedrock outcrops in the area, but bedrock is generally covered by till or outwash ranging in thickness from a few feet to 200 feet.

Within the target distance limit, the bedrock is hydraulically connected with the overlying unconsolidated deposits. Water levels recorded at any well that taps unconsolidated material likely reflect seasonal and annual water level trends in the bedrock. Sand and gravel deposits have moderate to high permeability in the range of 10^{-4} centimeters per second (cm/s) to 10^{-2} cm/s. USGS has calculated hydraulic conductivity of the bedrock in northern Westchester County to range from about 10^{-5} cm/s to 10^{-4} cm/s. Hydraulic conductivity of the bedrock varies with depth, but it is not closely related to the bedrock composition; topographic setting is the major factor in the distribution of hydraulic conductivity. The primary source of aquifer recharge is precipitation that infiltrates to the saturated zone. Mount Kisco receives approximately 45 inches of precipitation per year, and the net precipitation is greater than 30 inches per year. Groundwater flow is generally downward near hilltops and ridges and upward toward nearby streams and rivers. Water-table and artesian conditions occur in both unconsolidated deposits and bedrock.

Depth to water within the unconsolidated deposits at the site was approximately 4 feet bgs in December 2016; the depth of soil contamination at the site extends to 7 feet bgs. There is no dominant regional flow direction, but the general flow of groundwater is from hilltops toward nearby streams and reservoirs. Groundwater flow direction across the site is north-northeast. Due to the presence of the New Croton Reservoir approximately 2 miles northwest, overall groundwater flow is expected to be northwesterly. In areas that are supported by water supply wells and also have community sewerage such as Mount Kisco, the sewers prevent water pumped from the aquifer from

being returned to the groundwater system. The pumpage coupled with reduced recharge can cause groundwater levels to decline, and can influence groundwater flow direction.

Revision 1: The WWTP source is located less than 1.5 miles from the primary CRU source area and is adjacent to the Kisco River. The hydrogeological conditions at the location are expected to be similar to the primary source location.

Targets Associated with the Ground Water Migration Pathway

The largest groundwater supplies in Westchester County are obtained from sand and gravel, but the lateral extent of such deposits is limited. Water in usable quantities generally can be obtained anywhere in Westchester County from wells penetrating the bedrock. Historically, groundwater supplies in Westchester County have come from shallow wells (i.e., < 60 feet) in the sand and gravel or deeper wells in the bedrock; a majority of supply wells in the county withdraw water from bedrock. The Fordham Gneiss is the principal bedrock unit that underlies the site and surroundings, and it is the principal water-bearing material for wells within the 4-mile radius.

There are 42 active water-supply wells within the 4-mile TDL for the CRU site. The wells are associated with Community, Non-transient non-community (NTNC), and Transient non-community (TNC) water systems. Community water systems provide drinking water for residential populations, NTNC systems typically provide drinking water for institutions such as schools and worker populations, and TNC systems typically provide water supply to establishments that serve transient populations, such as restaurants and rest areas. The three categories of wells are evaluated as follows: non-transient populations served by Community and NTNC water systems are evaluated as target populations, whereas transient populations associated with TNC systems are not considered as target populations.

The groundwater samples collected by Region 2 SAT in December 2016 and June 2017 were from the nearest Community and NTNC supply wells, all located within approximately 1 mile of the site; as discussed previously, the analytical results for the samples do not meet observed release criteria. Therefore, actual contamination is not documented and all target populations, including those served by the sampled wells, are considered as subject to potential contamination. The nearest wells are located approximately 0.51 mile north-northwest of the site (i.e., in a downgradient direction). The groundwater population considered as subject to potential contamination within the 4-mile TDL is approximately 7,420; the associated distance-weighted population value is 1,155.

Revision 1: The WWTP source is located approximately 0.65 mile and possibly upgradient due to pumping influence from the Mount Kisco Water Department wellfield, four wells assigned an estimated combined population of 480 people. The Mount Kisco wells were not sampled during the previous investigations. The source is also located approximately 1 mile from the office park wells that were sampled previously; these wells were found to contain elevated levels of radionuclides, however, the wells are upgradient of the primary source area and the detected radionuclides were believed to be naturally-occurring. It is unknown if these radionuclides are attributable to the former WWTP source area.

Surface Water Migration Pathway

As described previously, the May 2014 sediment sampling documents an observed release to surface water of site-attributable contaminants by chemical analysis. Site runoff drains toward the northern and eastern portions of the site. Runoff of the site enters on-site storm drains and flows to the storm water pipe located along Kisco Avenue, which abuts the site to the west. The storm water pipe runs northeast from the site along Kisco Avenue, turns east and crosses beneath a parking lot and railroad tracks, and discharges to a perennial drainage ditch through an outfall located approximately 1,000 linear feet from the site. The outfall location is considered as the probable point of entry (PPE) to surface water. The documented observed release was limited to this perennial drainage ditch at and downstream of the PPE. A possible secondary runoff route would flow east onto the railroad ROW that abuts the site, and ultimately enter the perennial drainage ditch through overland flow. The perennial drainage ditch flows for approximately 0.2 mile from the PPE before discharging into Tributary 8 of the Kisco River. The in-water segment then continues for 0.9 mile along Tributary 8 until it meets the Kisco River, which flows northerly for 3.1 miles and discharges into New Croton Reservoir (part of Croton River). The New Croton Dam lies 6.3 miles downstream of the mouth of the Kisco River, at which point the in-water segment continues within the Croton River for 3.4 miles until it reaches Croton Bay. Croton Bay extends for 1 mile, where it meets the Hudson River. The in-water segment ends in the Hudson River 0.3 mile downstream from Croton Bay. The CRU site lies within the Croton Watershed.

Revision 1: The WWTP source is located within the same watershed as the primary source area. The PPE for this source is a stretch of the Kisco River south of the site. The in-water segment differs from the primary source area: it does not include the drainage ditch or Tributary 8, however, it does include an approximately 0.75-mile stretch of the Kisco River upstream of the confluence with Tributary 8. The TDL for the source includes the other water bodies mentioned above.

Targets Associated with the Surface Water Migration Pathway

One surface water intake is located along the 15-mile surface water pathway for the CRU site within the New Croton Reservoir. The New Croton Reservoir intake is approximately 10.2 miles downstream of the PPE, with a flow of 15,000 cubic feet per second (cfs); the intake serves approximately 831,000 people. There are available areas where fishing is allowed, including: the Kisco River (moderate stream), New Croton Reservoir (large river), Croton River (large stream), and Croton Bay (river). There are approximately 5.96 miles of HRS-eligible wetlands along the surface water pathway. The Federal Emergency Management Agency (FEMA) has designated the site property to be in an area of minimal flooding.

Revision 1: The 0.75-mile stretch of Kisco River from the WWTP source PPE to Tributary 8 is lined with HRS-eligible wetlands. The intake, fisheries, and sensitive environments mentioned above are also downstream of the WWTP source PPE.

Soil Exposure and Subsurface Intrusion Pathway

Soil contamination at the site is reported in historical surveys and it is confirmed by the investigations conducted by Region 2 SAT and RST 3 since 2013, as described previously. The available data from these investigations show that the contaminated soil is located across a large area beneath the site and to depths as great as 7 feet bgs. The site is mostly paved and enclosed with a maintained fence (i.e., stopping public access), as well as the presence of layers of asphalt and concrete over the contaminated soil. Some areas of observed contamination are paved, while others are unpaved; some areas of observed contamination are low-traffic areas used or traversed intermittently by on-site workers and not known to be used by the public. At least one source area is unpaved, located outside the fence, and accessible to the public.

Targets Associated with the Soil Exposure Pathway

The site is situated in a mixed commercial and residential area. There are eight residences within 200 feet of the site property, housing an estimated 22 people, however, no residences, schools, or day care centers are located on the properties where observed contamination is documented. There are approximately ten workers at New York Stone and Masonry Supply (105 Kisco Avenue). There are four to fifteen workers, depending on work load and season, at Hickory Homes and Properties, Inc. (103 Kisco Avenue). Approximately 9,047 people reside within 1 mile of the CRU site. There are no known terrestrial sensitive environments located on or within 200 feet of the site property.

Air Migration Pathway

A contaminant release from the facility to the ambient air is not observed. Although the presence of thoron at a slightly elevated level was documented during the November 2013 air monitoring event at the CRU site (as described previously), it is not considered to be attributable to site activities because the Th-232 decay series isotopes exhibited background levels and equilibrium in soil samples from the site. In addition, the 1994 EPA investigation did not indicate a release of contaminants from the site to the air. Radon measurements were taken from within the hardware store and outdoor storage shed. The results ranged from 1.0 pCi/L to 2.2 pCi/L which are below the EPA guideline of 4.0 pCi/L. A total of six air samples were collected from the property north and south of Railroad Avenue. Analysis of the samples for total alpha particle concentration indicated that all of the samples had less than the minimal detectable activity of 1×10^{-12} $\mu\text{R}/\text{cm}^3$. During previous reconnaissance and sampling activities, small amounts of dust generated by moving vehicles have been observed rising from the site.

Targets Associated with the Air Migration Pathway

Approximately 1,448 people reside within 0.25 mile of the site and a total of approximately 36,997 people reside within 4 miles of the site. There are approximately 1,129 acres of HRS-eligible wetlands within 4 miles of the site. According to NYSDEC, there is one state-listed threatened species habitat within 4 miles of the site.

REFERENCE LIST

1. U.S. Environmental Protection Agency (EPA). Superfund Chemical Data Matrix (SCDM) Query, Benchmarks for Substances: Cesium 137(+D), Lead 210(+D), Radium 226(+D), Radium 228(+D), Thorium 227, Thorium 228(+D), Thorium 230, Thorium 232, Thorium 234, Uranium 234, Uranium 235(+D), Uranium 238(+D) (radionuclides), Radium, and Uranium. A complete copy of SCDM is available at <http://www.epa.gov/superfund/superfund-chemical-data-matrix-scdm>. Query accessed September 18, 2017. [56 pages]
2. Weston Solutions, Inc. (WESTON). Figure 1: Facility Location Map; Figure 2: Site Aerial Map; Figure 3: Gamma Radiation Screening Results Map; Figure 4: Sample Location and Significant Data Results Map; Figure 5: Sample Location and Data Results Map; Figure 6: 4-Mile Radius Map; Figure 7: 15-Mile Pathway Map; Figure 8: Field Gamma Reading; and Figure 9: RAD7 Thoron and Radon Readings; Canadian Radium & Uranium Corp., 103/105 Kisco Avenue, Mount Kisco, NY. June 2014. [9 maps]
3. WESTON. Site Logbook Nos. 2222-4E-BJCB and 2222-4E-BKSP, Canadian Radium & Uranium Corp., TDD S05-0013-1307-009; with attached photo documentation. September to November 2013 and May 2014. [37 pages]
4. EPA. Hazard Ranking System; Final Rule, excerpts – 6.0 Air Migration Pathway and 7.0 Sites Containing Radioactive Substances. Federal Register, Volume 55, No. 241, pp. 51649–51667. December 14, 1990. [19 pages]
5. LD Didactic. The radioactive series of radium-226; based on R.R. Kinsey et al., *The NUDAT/PCNUDAT Program for Nuclear Data*, submitted to the 9th International Symposium of Capture-Gamma Ray Spectroscopy and Related Topics, Budapest, Hungary, October 1996. Data extracted from the NUDAT database December 18, 1997. From <https://www.ld-didactic.de/software/524221en/Content/Appendix/Ra226Series.htm>. [4 pages]
6. Breen, Denise, WESTON. Project Note to Canadian Radium & Uranium Corp. Site File, Subject: Determination of Site Boundary and Calculation of Site Acreage. October 7, 2013. [1 page]
7. Breen, Denise, WESTON. Project Note to Canadian Radium & Uranium Corp. Site File, Subject: Determination of population within the 4-mile target distance limit of the site. October 7, 2013. [2 pages]
8. Federal Emergency Management Agency (FEMA). Flood Insurance Rate Maps (FIRM), Town of Bedford, Village of Mount Kisco, Town of New Castle, Panel 153 of 426, Map Number 36119C0153F; excerpt. September 28, 2007. [3 pages]
9. Environmental Data Resources, Inc. (EDR). Inquiry Number 3730247.11 – The EDR Aerial Photo Decade Package, Canadian Radium & Uranium Corp., 103/105 Kisco Ave., Mount Kisco, NY 10549. September 19, 2013. [13 pages]

10. EDR. Inquiry Number 3730247.8s – The EDR Radius Map™ Report with GeoCheck®, Canadian Radium & Uranium Corp., 103/105 Kisco Ave., Mount Kisco, NY 10549. September 17, 2013. [227 pages]
11. EDR. Inquiry Number 3730247.9 – Certified Sanborn® Map Report, Canadian Radium & Uranium Corp., 103/105 Kisco Ave., Mount Kisco, NY 10549. September 17, 2013. [15 pages]
12. New York State Department of Environmental Conservation (NYSDEC). Radiological Survey for Village of Mt. Kisco and Richard's Lumber, former Canadian Radium and Uranium Corporation, Mt. Kisco, New York. July 1998. [202 pages]
13. Gilliland, G., WESTON. Project Note to Canadian Radium & Uranium Corp. site file, Subject: Groundwater Populations; with supporting documentation attached. September 11, 2017. [76 pages]
14. EPA. Final Draft – Preliminary Assessment Report and Remedial Site Assessment Decision, Canadian Radium & Uranium Corp., Mt. Kisco, New York. January 7, 1993. [18 pages]
15. Curran, Anita S., Westchester County Department of Health (WCDH). Letter to EPA Radiation Branch, with attached report by Calvin E. Weber, P.E.: Survey in Vicinity of Former Canadian Radium and Uranium Plant, Kisco Avenue, Village of Mount Kisco, Westchester County, New York. April 30, 1979. [3 pages]
16. New York State Department of Health (NYSDOH). Survey of the Former Canadian Radium Site, Mount Kisco, Westchester County, New York. October 1993. [46 pages]
17. Matuszek, J. M., Isotopes, Inc. Decontamination and Demolition of the Canadian Radium & Uranium Corporation Facility, Mount Kisco, New York. Final report prepared for the Mount Kisco Urban Renewal Agency. January 19, 1968. [23 pages]
18. Czerwinskyj, I., NYSDOH. Memorandum to Dr. K. Rimawi, Subject: Radium Contamination Investigation – Radium Chemical Plant Property, Mt. Kisco, Westchester County. February 7, 1980. [2 pages]
19. NYSDOH. Preliminary Radiological Survey Report on the Former Canadian Radium and Uranium Corporation Facility in Mt. Kisco, New York. November 3, 1988. [5 pages]
20. Merges, Paul J., NYSDEC. Letter to Howard Zane, Mt. Kisco Town Engineer, Re: Possible radioactive contamination of soil in the Town of Mt. Kisco. October 28, 1993. [2 pages]
21. Menken, David A., Office of the Village Attorney, Village/Town of Mount Kisco. Memorandum to Village Board of Trustees, Re: Richard's Home Center & Lumber v. Village/Town of Mount Kisco. July 2, 1998. [4 pages]

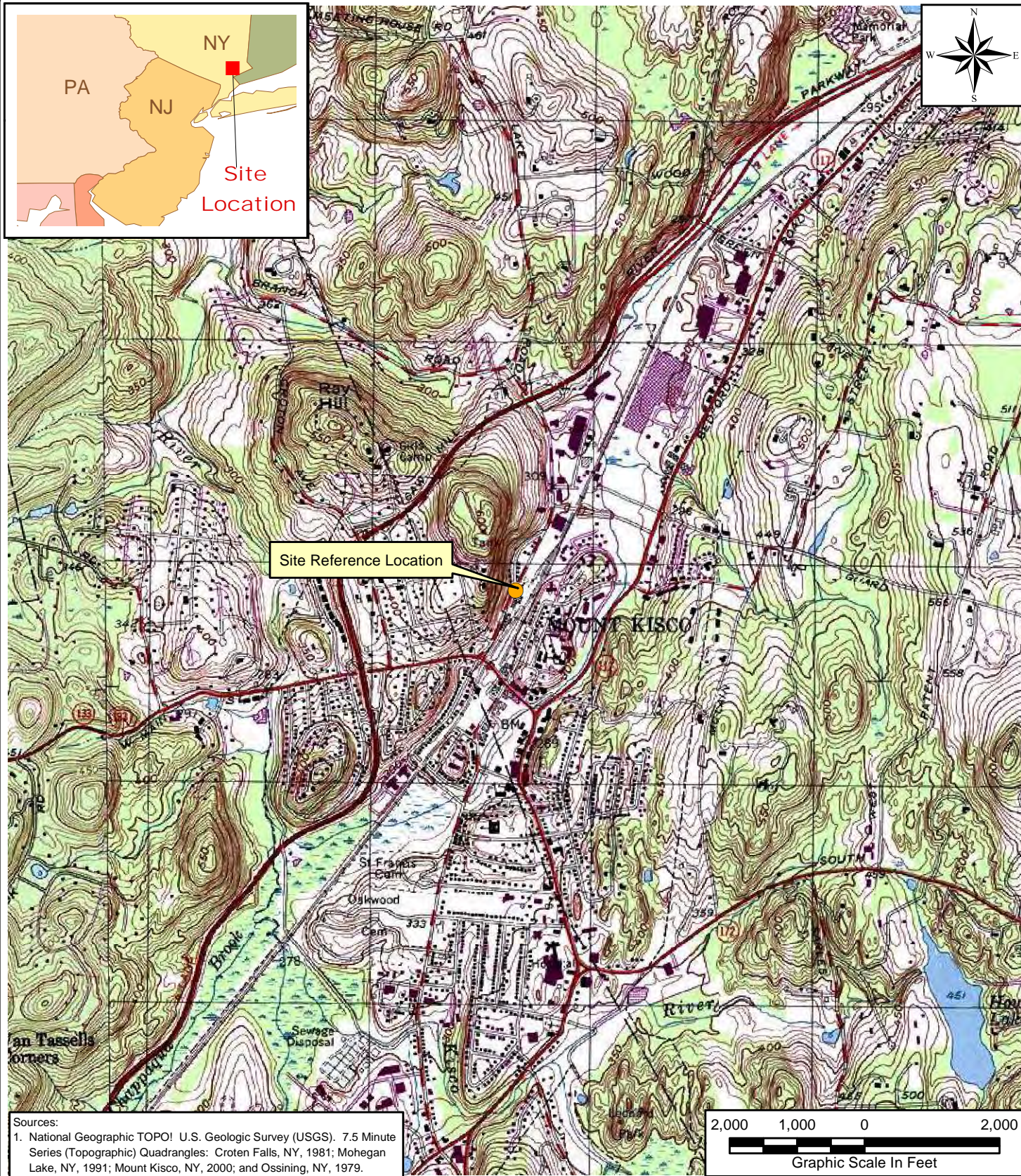
22. Palmer, James M., Assessor, Village of Mount Kisco. Memorandum to Patricia Dwyer, Village Manager, RE: Richard's Home Center & Lumber, 69.65-2-4, Paul Carozza and George Griffen, 69.65-2-5. December 10, 1998. [2 pages]
23. NYSDOH. Permit [for Canadian Radium and Uranium Corporation] to Dispose of Radioactive Wastes by Burial [at the Croton Point Park]. March 5, 1958. [4 pages]
24. Breen, Denise, WESTON. Project Note to Canadian Radium & Uranium Corp. File, Subject: Determination of the Number of People that Regularly Work on the Site. October 9, 2013. [3 pages]
25. NYSDEC. New York Nature Explorer, User Defined Results Report, Selected Map Areas [1-mile radius and 4-mile radius from Canadian Radium & Uranium Corp. site]. Accessed at <http://www.dec.ny.gov/natureexplorer/>. September 30, 2013. [2 pages]
26. Breen, Denise, WESTON. Project Note to Canadian Radium & Uranium Site File, Subject: Wetland Calculations. October 7, 2013. [1 page]
27. Croton Watershed Clean Water Coalition. Resources: Croton Watershed and Catskill/Delaware Maps. Accessed at www.newyorkwater.org/?PAGE=resources&sublink=map. November 17, 2013. [4 pages]
28. U.S. Census Bureau. QuickFacts from the US Census Bureau, Mount Kisco (village), New York. November 21, 2013. [2 pages]
29. Iowa Environmental Mesonet (IEM). IEM :: Site Wind Roses, White Plains Windrose Plot, Period of Record: 01 Nov 1970 – 30 Nov 2012. Accessed at http://mesonet.agron.iastate.edu/sites/windrose.phtml?station=HPN&network=NY_ASOS on September 22, 2013. [1 page]
30. Johnson, Nels R., WESTON. Project Note to Canadian Radium & Uranium Corp. Site File, Subject: Review of Test America Analytical Report for the Canadian Radium and Uranium Site. February 28, 2014. [5 pages]
31. Cheek, Samuel, WESTON. Project Note to Canadian Radium & Uranium Corp. Site File, Subject: Area of Observed Contamination Determination. February 10, 2014. [2 pages]
32. The New York Times. Toxic Water: A series about the worsening pollution in American waters and regulators' response, Ramleh Water Works Corp. Inc. Accessed at <http://projects.nytimes.com/toxic-waters/contaminants/ny/westchester/ny5922912-ramleh-water-works-corp-inc>. May 16, 2012. [2 pages]
33. U.S. Geological Survey (USGS). Water-resources data for the United States, Water Year 2013: USGS Water-Data Report WDR-US-2013, site 411421073481202. Accessed at <http://wdr.water.usgs.gov/wy2013/pdfs/411421073481202.2013.pdf>. 2014. [3 pages]

34. Yang, Yunru, WESTON. Validated Data, Lab Job No. 160-4690-1, Test America-St. Louis laboratory, Canadian Radium & Uranium (2222) site; DCN 2222-2F-BLIS. January 29, 2014. [21 pages]
35. EPA. Remedial Site Assessment Decision – EPA Region II, Site Name: Canadian Radium and Uranium, EPA ID#: NYD987001468. December 12, 1994. [1 page]
36. Argonne National Laboratory, EVS. Human Health Fact Sheet, Natural Decay Series: Uranium, Radium, and Thorium. August 2005. [4 pages]
37. EPA. Final Site Inspection Report, Canadian Radium and Uranium Corporation, Mt. Kisco, Westchester County, New York. December 1994. [637 pages]
38. Breen, Denise, WESTON. Sampling Trip Report, Work Assignment No. 2222, Canadian Radium & Uranium Corp. Site Reassessment; DCN: 2222-2A-BKSO. December 3, 2013. [14 pages]
39. CoolNet. Annual New York Rainfall and Climate Data. Downloaded from <http://coolweather.net/staterainfall/newyork.htm>. January 22, 2014. [2 pages]
40. TestAmerica. Analytical Report, Job Number: 160-4690-1, SDG Number: 2222, Job Description: Canadian Radium and Uranium. Prepared for WESTON. January 23, 2014. [2013 pages]
41. Perlmutter, Nathaniel M., USGS. Sources of Ground Water in Southeastern New York. Geological Survey Circular 417, prepared in cooperation with the New York State Water Power and Control Commission. 1960. [13 pages]
42. TestAmerica. Analytical Report, Job Number: 160-6694-1, Job Description: EPA Region 5 START 3 Contract. Prepared for WESTON. May 30, 2014. [2090 pages]
43. Yang, Yunru, WESTON. Data Assessment with validated data attached, Lab Job No. 160-6694-1, Test America-St. Louis laboratory, Canadian Radium & Uranium (2222) site, Analysis: Metals and Mercury. June 2, 2014. [13 pages]
44. Johnson, Nels R., and Denise Breen, WESTON. Project Note to Canadian Radium & Uranium Corp. Site File, Subject: Review of Test America Analytical Report for the Canadian Radium and Uranium Site - Sediment. June 5, 2014. [7 pages]
45. Breen, Denise, WESTON. Sampling Trip Report – Sediment Sampling, Work Assignment No. 2222, Canadian Radium & Uranium Corp. Site Reassessment; DCN: 2222-2A-BLXP. May 21, 2014. [14 pages]
46. Breen, Denise, WESTON. Project Note to Canadian Radium & Uranium Corp. Site File, Subject: Determination of Significant Lead Concentrations in Sediment Samples. June 5, 2014. [149 pages]

47. Nwosu, Bernard, WESTON. Phase II Removal Assessment Trip Report – Canadian Radium and Uranium Corp. Site, Mount Kisco, Westchester County, New York; DCN: RST3-03-D-0296. November 9, 2016. [37 pages]
48. Nwosu, Bernard, WESTON. Final Phase III Removal Assessment Trip Report – Canadian Radium and Uranium Corp. Site, Mount Kisco, Westchester County, New York; DCN: RST3-03-F-0130. May 15, 2017. [66 pages]
49. Breen, Denise, WESTON. Sampling Trip Report, TDD No. 0004/1611-05, Canadian Radium & Uranium Corp., Contract No. EP-S8-13-01 (Region 8 START IV); DCN: W0428.1A.01189. December 13, 2016. [36 pages]
50. White, Cynthia, National Analytical Radiation Environmental Laboratory (NAREL), EPA. Memorandum to Andrew Fessler, Region 2, Subject: Radiochemical Results for Canadian Radium & Uranium Samples; with attached data package for gross alpha and beta analysis. January 5, 2017. [19 pages]
51. White, Cynthia, NAREL, EPA. Memorandum to Andrew Fessler, Region 2, Subject: Radiochemical Results for Canadian Radium & Uranium Samples; with attached data package for gamma, radium-226, and isotopic uranium and thorium analysis. January 31, 2017. [67 pages]
52. Haaker, Rick, WESTON. Memorandum to Andrew Fessler, EPA and Gerald V. Gilliland, WESTON, Subject: Radiochemical data validation for NAREL Sample Delivery Group 1600054 in regards to Canadian Radium Site, Mount Kisco, Westchester County, New York. March 17, 2017. [27 pages]
53. WESTON. Figure 1: Surficial Geology Map; Figure 2: Bedrock Geology Map; Figure 3: New York State Unconsolidated Aquifer Map; and Figure 4: New York State Water Wells Map; Canadian Radium & Uranium Corp. April 2017. [4 maps]
54. Asselstine, E.S. and I.G. Grossman, USGS. The Ground Water Resources of Westchester County, New York, Part I, Records of Wells and Test Holes. Bulletin GW-35, prepared in cooperation with New York Water Power and Control Commission. 1955. [85 pages]
55. Linsey, Kristin S. et al., USGS. Identification of Potential Water-Resources-Monitoring Sites in the Croton Reservoir System, Southeastern New York. Open-File Report 97-638, prepared in cooperation with New York City Department of Environmental Protection (NYCDEP). 1999. [41 pages]
56. Wolcott, Stephen W. and Robert F. Snow, USGS. Computation of Bedrock-Aquifer Recharge in Northern Westchester County, New York, and Chemical Quality of Water from Selected Bedrock Wells. Water-Resources Investigations Report 92-4157, prepared in cooperation with Westchester County Water Agency. 1995. [65 pages]
57. USGS. Principal Aquifers Can Contribute Radium to Sources of Drinking Water Under Certain Geochemical Conditions. Fact Sheet 2010-3113. January 2012. [6 pages]

58. Wolcott, Stephen W. and Don J. Irwin, USGS. Estimated Thickness and Potential Well Yield of Stratified-Drift Deposits in the Upper Croton River Basin, Westchester County, New York. Water-Resources Investigations Report 87-4287, prepared in cooperation with Westchester County Water Agency. 1988. [6 maps]
59. Reynolds, Richard J., USGS. Hydrogeology of the Croton-Ossining Are, Westchester County, New York, and Chemical Quality of Water from Selected Bedrock Wells. Water-Resources Investigations Report 87-4159, prepared in cooperation with NYSDEC. 1988. [5 maps]
60. Frederick P. Clarke Associates, Inc. Comprehensive Development Plan, Village/Town of Mount Kisco. Prepared for Village/Town of Mount Kisco. August 2000. [99 pages]
61. USGS. New York. Fact Sheet 033-99. September 1999. [4 pages]
62. Breen, Denise, WESTON. Sampling Trip Report, TDD No. 0004/1611-05, Canadian Radium & Uranium Corp., Contract No. EP-S8-13-01 (Region 8 START IV); DCN: W0428.1A.01353. July 6, 2017. [41 pages]
63. Pace Analytical Services, Inc. (PACE). Pace-Pittsburgh Project No. 30222947 Rev. 1, Client Ref. 0428-WSW. Prepared for WESTON. September 6, 2017. [1047 pages]
64. Geng, Pei, Laboratory Data Consultants, Inc. (LDC). Phase 2 Water-Supply Well Sampling, Data Validation Report; with final EDD attached. September 8, 2017. [112 pages]
65. NYSDEC. Field Investigation Report, Morgan Drive, Lot 3 Site (360137) at 2 Morgan Drive, Mt. Kisco, NY and Undeveloped Parcel Site (C360112) at 6 Morgan Drive, Mt. Kisco NY. Date of Visit: December 20, 2017. [22 pages]
66. WCDH. Subdivision, Prepared for Radio Circle Business Park, Inc., located in the Village/Town of Mt. Kisco, Westchester County, NY; Westchester County Index Sheet 159 Block 9422. February 10, 1989. [1 map]
67. Carlin-Simpson & Associates. Figure 5, BCA Site No. C360112, Undeveloped Parcel Site, Mt. Kisco, New York, Project No. 01-109. Based on October 2003 Drawing by H. Stanley Johnson and Company Land Surveyors, P.C. Undated. [1 map]
68. City of New York Dept. of Water Supply, Gas & Electricity, Bureau of Water Supply. Maps for Sewage Disposal Plant Mt. Kisco, NY: General Plan of Proposed Alterations and Extensions (September 1937); Proposed Renovation of Sand Filter Bed No. 9 (October 1943); Test Borings (June 1961); and Plan of Existing Site, Temporary Equipment and Piping (July 1961). 1937 to 1961. [4 maps]
69. WESTON. Source Locations and Former Mt Kisco WWTP Location, Canadian Radium & Uranium Corp. Site. Google Earth (© 2018 Google). September 2019. [2 maps]

FIGURES



LEGEND:

● Site Reference Location

PROJECT: Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

CLIENT NAME: EPA

TITLE:

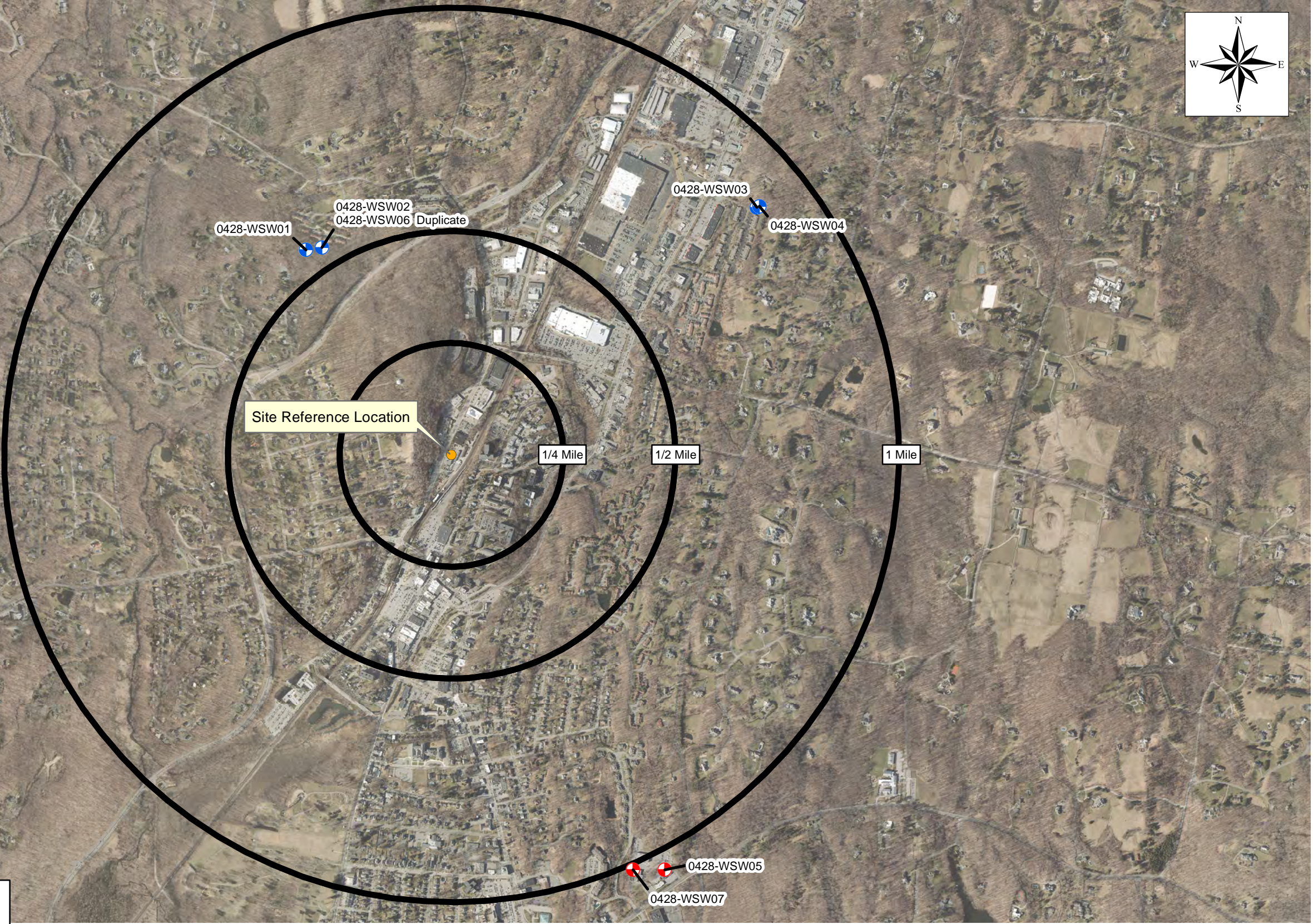
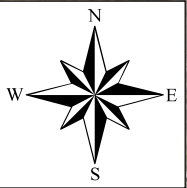
Site Location Map
Canadian Radium & Uranium Corp.
Mount Kisco, NY

WESTON
SOLUTIONS

DATE: September 2017

FIGURE #: 1

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Legend

- Site Reference Point
- Active Community Well Sample Location⁽²⁾
- Active Non-Transient Non-Community Well Sample Location⁽²⁾

SOURCES:

- Westchester County High Resolution Orthoimage 2013, Sai Pinnepalli, IIC Technologies, Inc. Manager, GIS Services, April 2013.
- Well information provided by the USEPA on June 10th, 2013.
- U.S Department of the Interior, Fish and Wildlife Service, St. Petersburg, FL. National Wetlands Inventory. <http://www.nwi.fws.gov>. Date January 1st, 2013.

SCALE:
1,260 630 0 1,260
Graphic Scale in Feet

PROJECT: Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

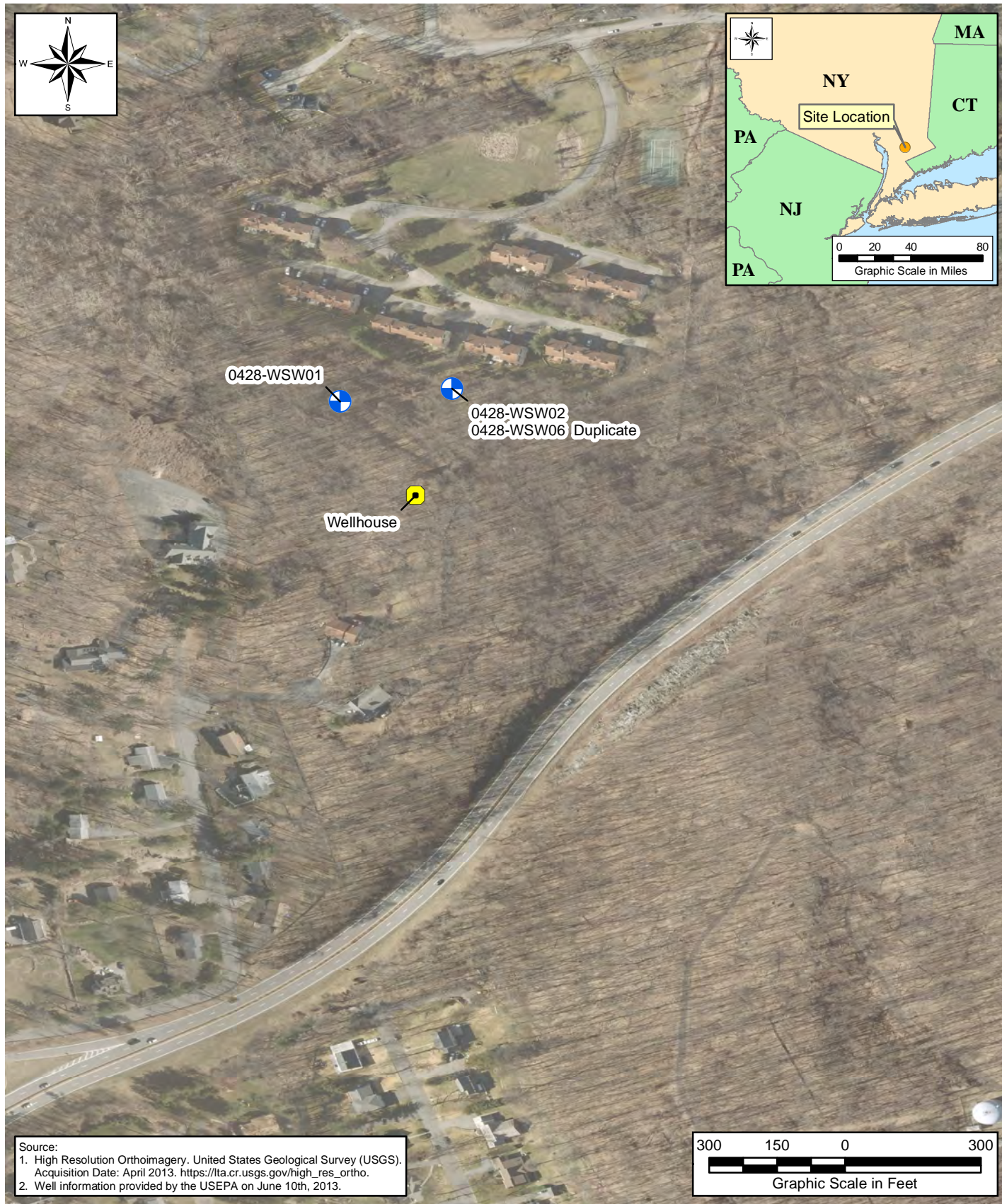
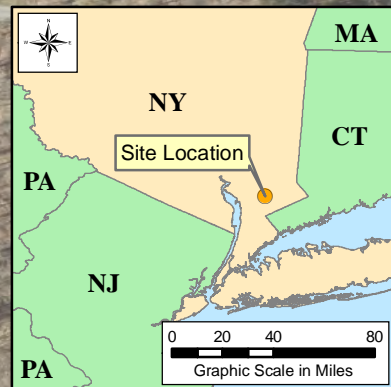
CLIENT NAME: EPA

TITLE: Sample Location Map - December 6, 2016
Water Supply Well Sampling
Site Reassessment
Canadian Radium & Uranium Corp.

DATE: September 2017



FIGURE #: 2

WESTON SOLUTIONS SM



Source:
 1. High Resolution Orthoimagery. United States Geological Survey (USGS).
 Acquisition Date: April 2013. https://lta.cr.usgs.gov/high_res_ortho.
 2. Well information provided by the USEPA on June 10th, 2013.

LEGEND:

-  Wellhouse Location
-  Active Community Well Sample Location⁽²⁾

PROJECT:

Canadian Radium & Uranium Corp.
 TDD No. 0004/1611-05

CLIENT NAME:

EPA

TITLE:

Sample Location Map
 Ramleh Water Works Corp. Inc.
 Site Reassessment
 Canadian Radium & Uranium Corp.

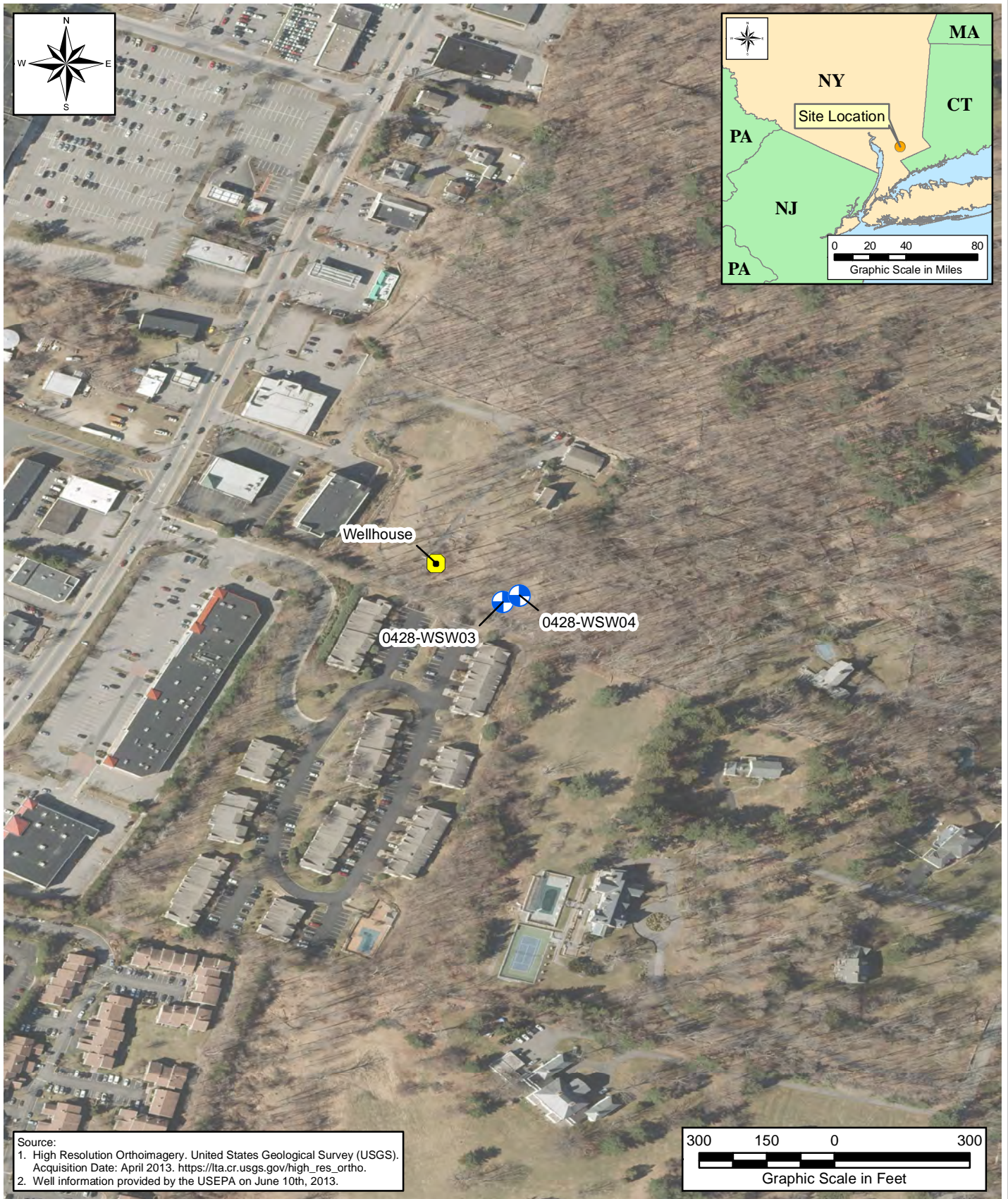
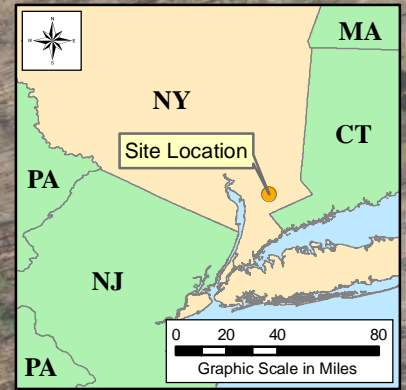


DATE:

September 2017

FIGURE #:

2A



Source:
1. High Resolution Orthomagery. United States Geological Survey (USGS).
Acquisition Date: April 2013. https://ita.cr.usgs.gov/high_res_ortho.
2. Well information provided by the USEPA on June 10th, 2013.

LEGEND:



Wellhouse Location



Active Community Well
Sample Location⁽²⁾

PROJECT:

Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

CLIENT NAME:

EPA

TITLE:

Sample Location Map
796 Bedford Road Apartments
Site Reassessment
Canadian Radium & Uranium Corp.

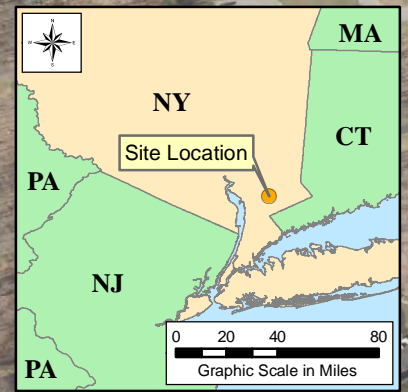


DATE:

September 2017

FIGURE #:

2B



Source:
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Acquisition Date: April 2013. https://lta.cr.usgs.gov/high_res_ortho.
2. Well information provided by the USEPA on June 10th, 2013.

LEGEND:



Wellhouse Location



Active Non-Transient Non-Community
Well Sample Location⁽²⁾

PROJECT:

Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

CLIENT NAME:

EPA

TITLE:

Sample Location Map
Northern Westch Professional Park
Site Reassessment
Canadian Radium & Uranium Corp.



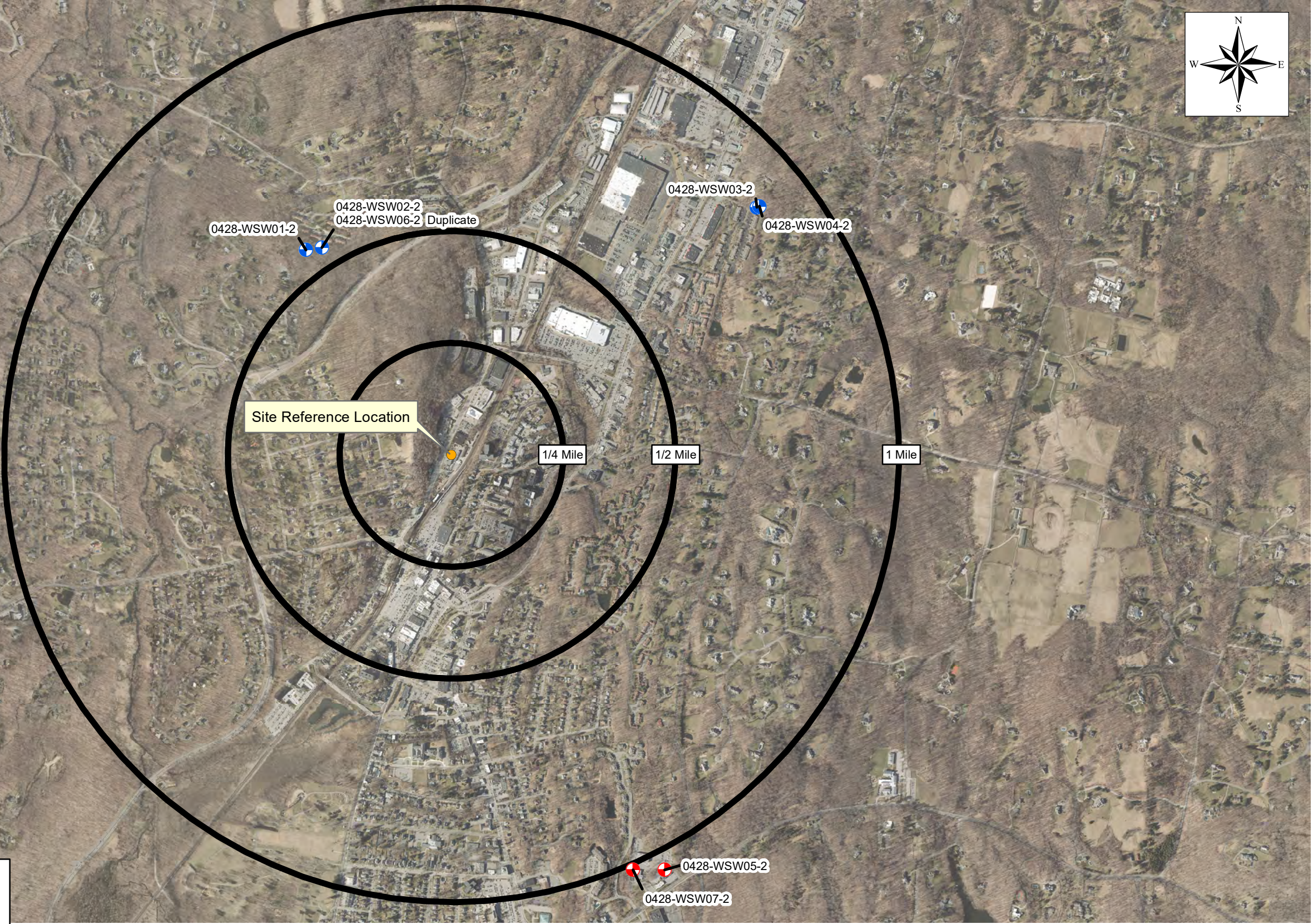
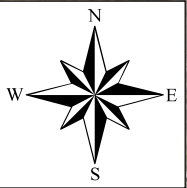
DATE:

September 2017

FIGURE #:

2C

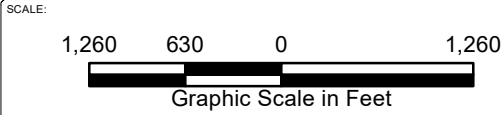
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Legend

- Site Reference Point
- Active Community Well Sample Location⁽²⁾
- Active Non-Transient Non-Community Well Sample Location⁽²⁾

SOURCES:
1. Westchester County High Resolution Orthoimage 2013, Sai Pinnepalli, IIC Technologies, Inc, Manager, GIS Services, April 2013.
2. Well information provided by the USEPA on June 10, 2013.
3. U.S Department of the Interior, Fish and Wildlife Service, St. Petersburg, FL. National Wetlands Inventory. <http://www.nwi.fws.gov>. Date January 1st, 2013.
4. Weston Solutions, Inc. Region 2 Site Assessment Team, Site Logbook, DCN: W0428.3B.01182, December 2016 – June 2017.



PROJECT: Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

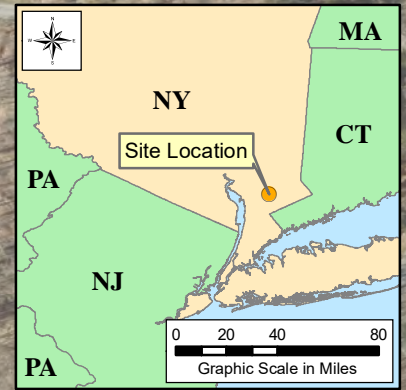
CLIENT NAME: EPA

TITLE: Re-Sampling Location Map – June 2017
Water Supply Well Sampling
Site Reassessment
Canadian Radium & Uranium Corp.



DATE: September 2017

FIGURE #: 3



0428-WSW01-2



0428-WSW02-2
0428-WSW06-2 Duplicate

Wellhouse



Source:
1. High Resolution Orthoimagery, United States Geological Survey (USGS).
Acquisition Date: April 2013. https://ita.cr.usgs.gov/high_res_ortho.
2. Well information provided by the USEPA on June 10, 2013.
3. Weston Solutions, Inc. Region 2 Site Assessment Team,
Site Logbook, DCN: W0428.3B.01182, December 2016 – June 2017.

300 150 0 300
Graphic Scale in Feet

LEGEND:



Wellhouse Location



Active Community Well
Sample Location⁽²⁾

PROJECT:

Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

CLIENT NAME:

EPA

TITLE:

Re-Sampling Location Map
Ramleh Water Works Corp. Inc.
Site Reassessment
Canadian Radium & Uranium Corp.

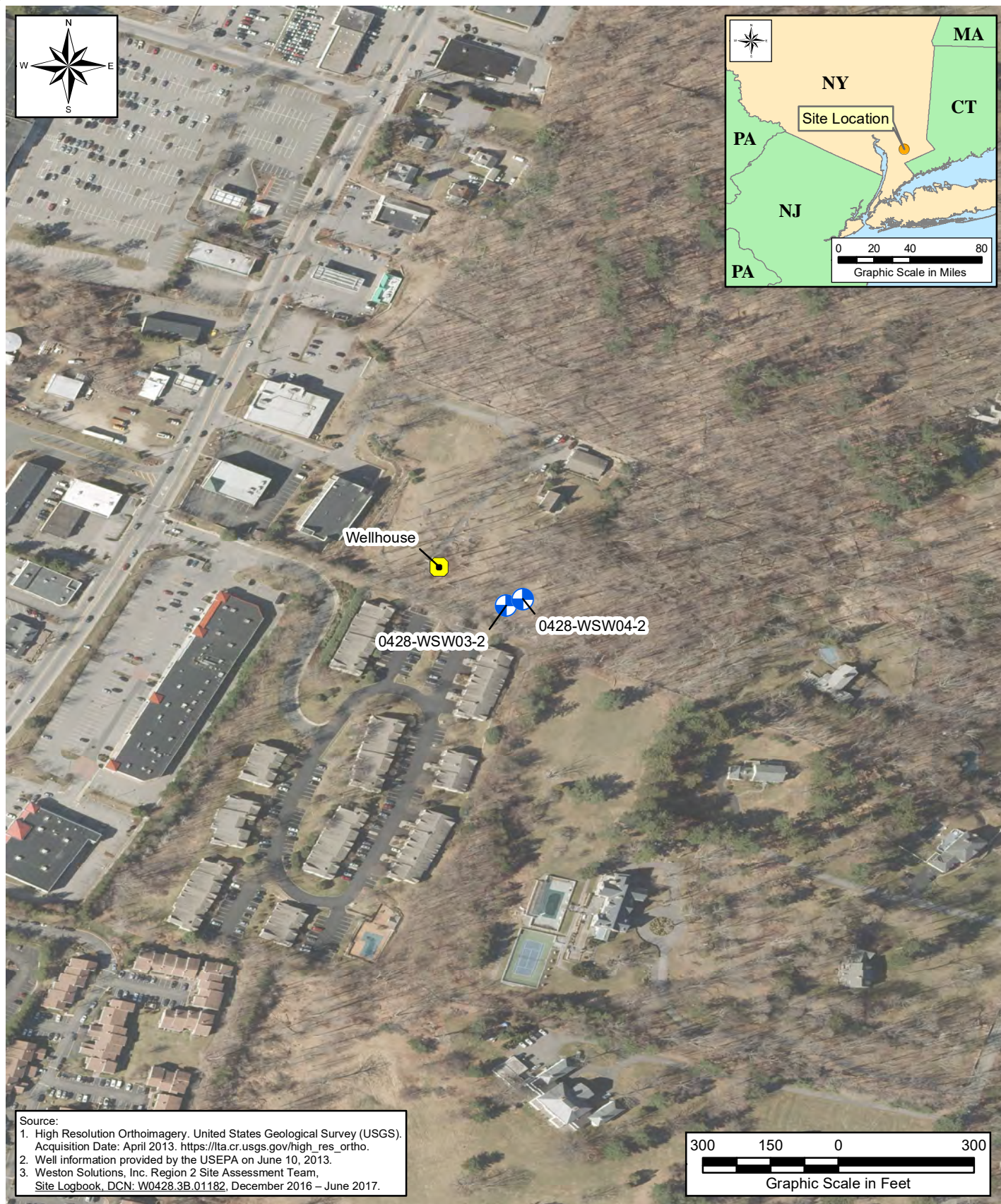


DATE:



September 2017

FIGURE #:

3A



LEGEND:

-  Wellhouse Location
-  Active Community Well Sample Location⁽²⁾

PROJECT:

Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

CLIENT NAME:

EPA

TITLE:

Re-Sampling Location Map
796 Bedford Road Apartments
Site Reassessment
Canadian Radium & Uranium Corp.

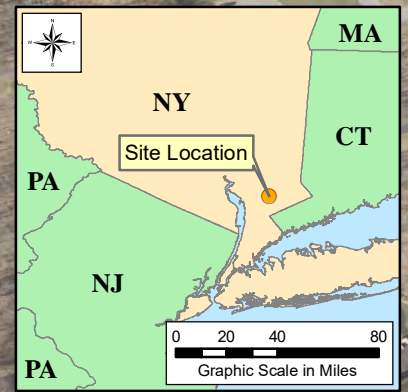


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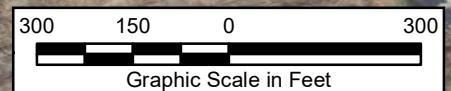
September 2017

FIGURE #:

3B



Source:
 1. High Resolution Orthoimagery. United States Geological Survey (USGS).
 Acquisition Date: April 2013. https://ita.cr.usgs.gov/high_res_ortho.
 2. Well information provided by the USEPA on June 10, 2013.
 3. Weston Solutions, Inc. Region 2 Site Assessment Team,
 Site Logbook, DCN: W0428.3B.01182, December 2016 – June 2017.



LEGEND:

- Wellhouse Location
- Active Non-Transient Non-Community Well Sample Location⁽²⁾

PROJECT:

Canadian Radium & Uranium Corp.
 TDD No. 0004/1611-05

CLIENT NAME:

EPA

TITLE:

Re-Sampling Location Map
 Northern Westch Professional Park
 Site Reassessment
 Canadian Radium & Uranium Corp.



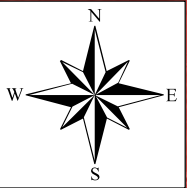
DATE:

September 2017

FIGURE #:

3C

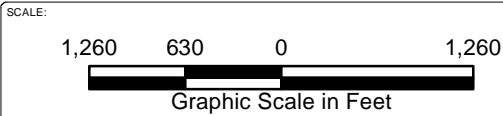
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Legend

- Site Reference Point
- Active Community Well Sample Location⁽²⁾
- Active Non-Transient Non-Community Well Sample Location⁽²⁾
- Geology**
 - Bedrock.
 - Outwash sand and gravel: Coarse to fine gravel with sand, proglacial fluvial deposition, well rounded and stratified, generally finer texture away from ice border, permeable, thickness variable (2-20 meters)
 - Kame deposits: Coarse to fine gravel and/or sand, includes kames, eskers, kame terraces, kame deltas, ice contact, or ice cored deposition, lateral variability in sorting, texture and permeability, may be firmly cemented with calcareous cement, thickness variable (10-30 meters)
 - Till Variable texture: poorly sorted sand-rich diamict, deposition beneath glacier ice, permeability varies with compaction, thickness variable (1-50 meters)

SOURCES:
1. Westchester County High Resolution Orthoimage 2013, Sai Pinnepalli, IIC Technologies, Inc, Manager, GIS Services, April 2013.
2. Well information provided by the USEPA on June 10th, 2013.
3. U.S Department of the Interior, Fish and Wildlife Service, St. Petersburg, FL. National Wetlands Inventory. <http://www.nwi.fws.gov>, Date January 1st, 2013.
4. Integrated Geologic Map Databases for the United States: Delaware, Maryland, New York, Pennsylvania, and Virginia Edition: version 1.0 - U.S. Geological Survey, 2005.



PROJECT: Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

CLIENT NAME: EPA

TITLE:

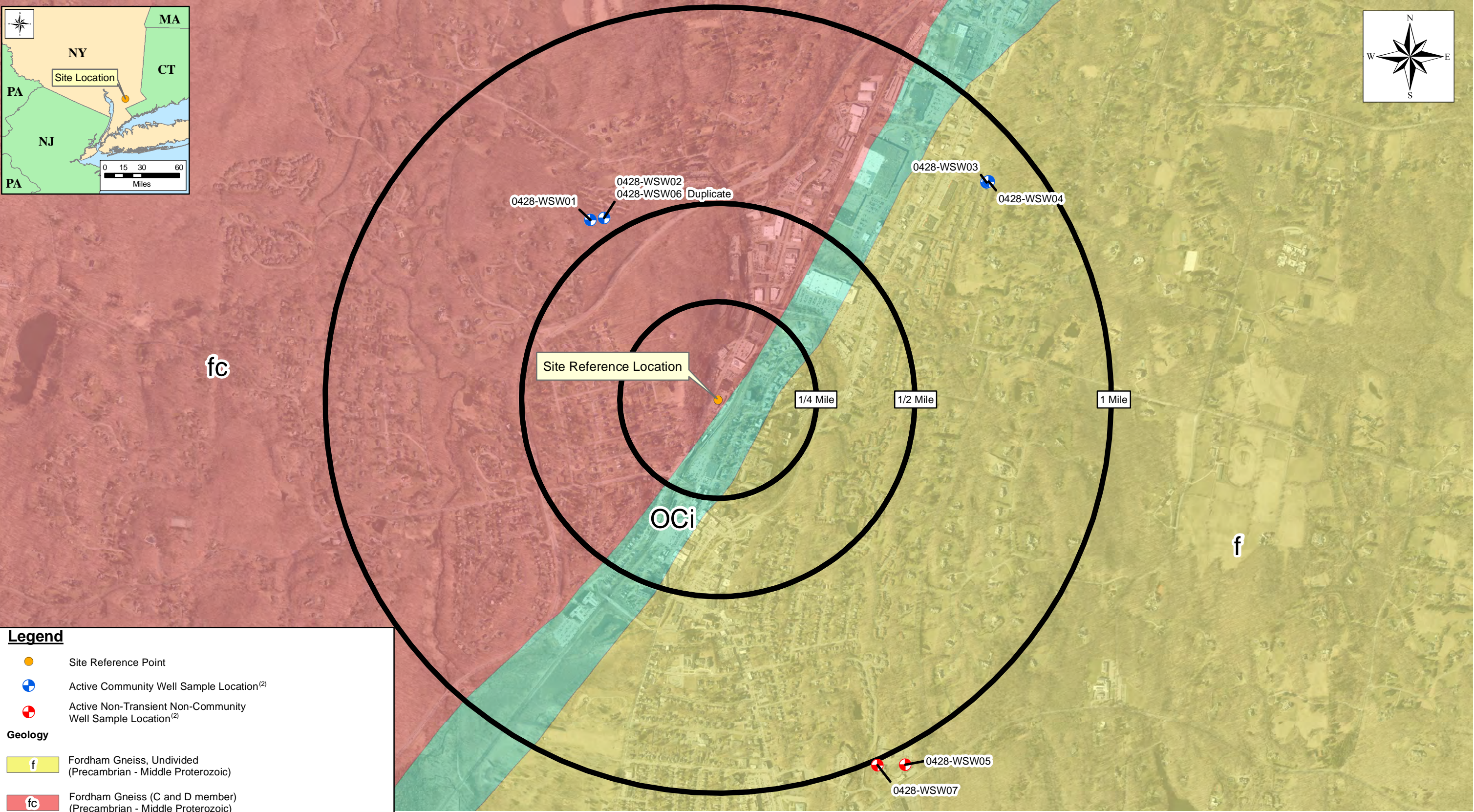
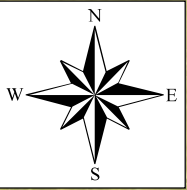
Surficial Geology Map
Canadian Radium & Uranium Corp.






DATE: September 2017

FIGURE #: 4




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Legend

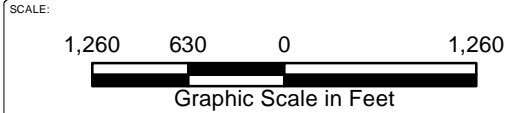
-  Site Reference Point
-  Active Community Well Sample Location⁽²⁾
-  Active Non-Transient Non-Community Well Sample Location⁽²⁾

Geology

-  Fordham Gneiss, Undivided (Precambrian - Middle Proterozoic)
-  Fordham Gneiss (C and D member) (Precambrian - Middle Proterozoic)
-  Inwood Marble (Early Cambrian - Lower Ordovician)

NOTES:
1. Fordham Gneiss, undivided: fe: garnet-biotite-quartz-plagioclase gneiss, and amphibolite;
fd: sillimanite-garnet schistose gneiss, quartzite;
fc: biotite-hornblende-quartz-plagioclase gneiss, quartz-feldspar lenses, amphibolite, biotite and/or hornblende-quartz-feldspar gneiss;
fb: amphibolite, biotite and/or hornblende-garnet-quartz-plagioclase gneiss;
fa: garnet-biotite-quartz-plagioclase gneiss, amphibolite, biotite-hornblende-quartz-plagioclase gneiss, quartz-feldspar granulite.

SOURCES:
1. Westchester County High Resolution Orthoimage 2013,
Sai Pinnepalli, IIC Technologies, Inc, Manager, GIS Services, April 2013.
2. Well information provided by the USEPA on June 10th, 2013.
3. Integrated Geologic Map Databases for the United States:
Delaware, Maryland, New York, Pennsylvania, and Virginia Edition: version 1.0 - U.S. Geological Survey, 2005.



PROJECT: Canadian Radium & Uranium Corp.
TDD No. 0004/1611-05

CLIENT NAME: EPA

TITLE: **Bedrock Geology Map**
Canadian Radium & Uranium Corp.



DATE: September 2017

FIGURE #: 5

TABLES

TABLE 1
WATER-SUPPLY-WELL SAMPLE LOCATIONS
CANADIAN RADIUM AND URANIUM CORP. – SITE REASSESSMENT

DCN: W0428.1A.01313

Public Water System ID	Water System Well Name	Sample ID	Latitude (decimal degrees)	Longitude (decimal degrees)	Approx. Ground Surface Elevation (ft ± MSL)
NY5922912	Deer Ridge Well 1	0428-WSW01	41.2189310	-73.7334740	420
	Deer Ridge Well 2	0428-WSW02	41.2190110	-73.7327970	400
		0428-WSW06 (DUP)			
NY5930069	Bedford Rd Apts Well 1	0428-WSW03	41.2201790	-73.7141160	440
	Bedford Rd Apts Well 2	0428-WSW04	41.2202210	-73.7140140	440
NY5922308	NWPP 101	0428-WSW05	41.1987500	-73.7183350	370
NY5930006	NWPP 103-105	0428-WSW07	41.1987490	-73.7196910	360

Notes:

1. Water system NY5922912 is listed as "Ramleh Water Works Corp. Inc." in EPA's Safe Drinking Water Information System (SDWIS).
2. Water system NY5930069 is listed as "796 Bedford Road Apartments" in SDWIS.
3. NWPP = Northern Westchester Professional Park

TABLE 2

WATER-SUPPLY-WELL ANALYTICAL RESULTS – DECEMBER 2016 (PHASE 1)

CANADIAN RADIUM AND URANIUM CORP. – SITE REASSESSMENT

DCN: W0428.1A.01313

Location:	Bedford Rd Apts Well 1 0428-WSW03 12/6/2016				Bedford Rd Apts Well 2 0428-WSW04 12/6/2016				Criteria for Significance above Background			Deer Ridge Well 1 0428-WSW01 12/6/2016				Deer Ridge Well 2 0428-WSW02 12/6/2016				Deer Ridge Well 2 0428-WSW06 12/6/2016				NWPP 101 0428-WSW05 12/6/2016				NWPP 103-105 0428-WSW07 12/6/2016								HRS Benchmarks	
Field Sample ID:	Site-Specific Background (SSBG)				Site-Specific Background (SSBG)							-				Field Duplicate of 0428- WSW02				Laboratory Duplicate Samples								Minimum	Source								
Date:									Mean	Max.	Mean																					Value					
Comments:	Result	Q	2S	MDC	Result	Q	2S	MDC	SSBG	2S	SSBG + Max. 2S	Result	Q	2S	MDC	Result	Q	2S	MDC	Result	Q	2S	MDC	Result	Q	2S	MDC	Result	Q	2S	MDC	Result	Q	2S	MDC		
Radioisotope																																					
Bismuth-212 (Bi-212)	0.25	U	7.92	13.4	-0.64	U	23.7	12.0	-0.2	23.7	23.5	-0.25	U	43.9	12.7	1.35	U	7.48	12.6	-0.35	U	13.9	12.5	-0.27	U	58.0	12.4	-0.35	U	3980	12.1	0.78	U	7.04	11.9	n/a	n/a
Bismuth-214 (Bi-214)	0.24	UJ	1.23	2.16	0.61	UJ	1.08	1.69	0.43	1.23	1.66	4.87	J	1.42	1.81	1.43	UJ	1.21	1.78	-0.24	UJ	1.32	1.71	0.03	UJ	1.20	1.84	-0.17	UJ	1.31	1.76	0.40	UJ	1.26	1.86	n/a	n/a
Cesium-137 (C-s137)	0.13	U	0.54	0.92	-0.09	U	0.48	0.82	0.02	0.54	0.56	-0.12	U	0.60	1.00	-0.14	U	0.58	0.97	-0.44	U	0.61	1.00	0.13	U	0.53	0.90	0.02	U	0.57	0.96	-0.20	U	0.56	0.94	1.71	CRSC
Lead-210 (Pb-210)	-2.80	U	18.8	22.0	2.77	U	11.5	18.1	0.0	18.8	18.8	-4.14	U	23.2	22.4	-4.46	U	24.4	22.4	-0.35	U	13.3	21.6	-0.58	U	13.7	21.6	-2.74	U	18.9	22.2	1.37	U	12.7	21.6	0.0411	CRSC
Lead-212 (Pb-212)	0.80	U	1.08	1.78	0.92	U	1.10	1.80	0.86	1.10	1.96	0.91	U	1.13	1.85	0.72	U	1.11	1.83	0.80	U	1.08	1.77	1.26	U	1.10	1.79	1.06	U	1.09	1.79	1.78	--	1.00	1.42	n/a	n/a
Lead-214 (Pb-214)	0.74	UJ	1.45	2.09	0.12	UJ	1.36	2.34	0.43	1.45	1.88	3.52	J	1.45	2.01	0.60	UJ	1.41	2.40	-0.44	UJ	2.30	2.36	-0.52	UJ	2.53	2.33	-0.64	UJ	2.92	2.30	-0.40	UJ	2.11	2.27	n/a	n/a
Potassium-40 (K-40)	-9.82	U	23.1	11.3	-3.34	U	8.69	11.0	-6.6	23.1	16.5	5.40	U	8.82	11.1	3.41	U	8.13	10.8	4.15	U	8.73	11.0	6.94	U	7.35	9.98	7.19	U	7.97	10.2	5.70	U	7.63	10.3	n/a	n/a
Radium-226 (Ra-226)	0.65	J	0.23	0.13	0.65	J	0.22	0.12	0.65	0.23	0.88	1.07	J	0.30	0.13	1.14	J	0.35	0.12	0.31	J	0.15	0.10	0.56	J	0.20	0.12	0.38	J	0.18	0.14	0.51	J	0.20	0.12	0.135	CRSC
Radium-228 (Ra-228)	1.81	U	1.98	3.24	2.19	U	1.92	3.10	2.00	1.98	3.98	3.38	--	2.02	3.16	2.39	U	2.04	3.28	2.85	U	2.05	3.26	2.51	U	1.98	3.18	1.95	U	1.87	3.02	0.86	U	1.85	3.08	0.0502	CRSC
Total Radium (calculated)	2.46		2.21		2.84		2.14		2.65	2.21	4.86	4.45				3.53				3.16				3.07				2.33			1.37			n/a	n/a		
Thallium-208 (Tl-208)	0.06	U	0.59	1.02	-0.10	U	0.81	1.00	-0.02	0.81	0.79	-0.17	U	1.08	1.01	-0.14	U	1.00	1.03	-0.26	U	1.54	0.98	0.02	U	0.58	1.01	-0.06	U	0.70	1.00	0.00	U	0.58	1.01	n/a	n/a
Thorium-227 (Th-227)	0.00	U	0.09	0.22	-0.01	U	0.05	0.14	-0.01	0.09	0.09	-0.01	U	0.06	0.16	0.08	U	0.11	0.13	-0.01	U	0.06	0.15	0.02	U	0.08	0.16	0.00	U	0.08	0.19	0.00	U	0.05	0.13	1.08	CRSC
Thorium-228 (Th-228)	0.08	U	0.08	0.10	0.10	U	0.09	0.11	0.09	0.09	0.18	0.17	--	0.12	0.15	0.01	U	0.07	0.14	0.12	U	0.10	0.14	0.16	--	0.12	0.13	0.07	U	0.08	0.11	0.00	U	0.07	0.15	0.1	CRSC
Thorium-230 (Th-230)	0.13	U	0.17	0.28	0.00	U	0.14	0.27	0.07	0.17	0.24	0.01	U	0.14	0.28	0.18	U	0.17	0.27	0.09	U	0.16	0.27	0.07	U	0.15	0.27	0.05	U	0.15	0.27	0.09	U	0.15	0.27	0.571	CRSC
Thorium-232 (Th-232)	0.02	U	0.06	0.11	0.00	U	0.03	0.08	0.01	0.06	0.07	-0.02	U	0.04	0.12	0.03	U	0.05	0.08	0.00	U	0.03	0.07	0.01	U	0.04	0.09	0.04	U	0.06	0.07	0.00	U	0.05	0.11	0.517	CRSC
Thorium-234 (Th-234)	1.50	U	15.5	25.8	-0.14	U	15.1	25.2	0.7	15.5	16.2	7.26	U	15.9	26.3	-10.3	U	14.5	23.9	4.89	U	15.5	25.7	11.9	U	14.0	23.0	0.36	U	15.0	25.0	2.92	U	13.9	23.1	2.26	CRSC
Uranium-234 (U-234)	0.20	--	0.11	0.10	0.06	U	0.07	0.11	0.13	0.11	0.24	0.16	--	0.10	0.09	0.32	--	0.17	0.14	0.37	--	0.15	0.08	1.88	--	0.37	0.10	0.43	--	0.16	0.09	0.26	--	0.16	0.20	0.739	CRSC
Uranium-235 (U-235)	0.09	U	0.09	0.11	0.01	U	0.05	0.11	0.05	0.09	0.14	0.02	U	0.05	0.09	0.03	U	0.09	0.16	0.03	U	0.06	0.08	0.10	U	0.09	0.10	0.06	U	0.08	0.10	0.01	U	0.09	0.19	0.727	CRSC
Uranium-238 (U-238)	0.09	U	0.08	0.10	0.13	--	0.09	0.07	0.11	0.09	0.20	0.16	--	0.10	0.09	0.22	--	0.14	0.10	0.24	--	0.12	0.07	1.32	--	0.30	0.09	0.20	--	0.12	0.10	0.22	--	0.13	0.15	0.60	CRSC
Gross Alpha	1.17	U	4.17	3.32	4.82	--	4.82	3.25	3.00	4.82	7.82	3.45	U	5.39	3.78	4.11	U	6.23	4.26	1.81	UJ	7.61	5.89	6.10	UJ	20.5	16.0	-0.78	UJ	7.89	6.90			n/a		n/a	n/a
Gross Alpha (lab dup.)			n/a				n/a				n/a	3.47	U	5.58	4.31			n/a				n/a				n/a				n/a		n/a		n/a	n/a	n/a	
Gross Beta	7.42	--	3.26	4.34	7.00	--	3.22	4.33	7.21	3.26	10.5	12.1	--	3.60	4.46	11.2	--	3.47	4.36	12.2	--	6.29	8.65	8.36	UJ	11.2	16.5	4.91	UJ	5.27	7.57			n/a		n/a	n/a
Gross Beta (lab dup.)			n/a				n/a				n/a	9.3	--	3.32	4.31			n/a				n/a				n/a				n/a		n/a		n/a	n/a	n/a	

All sample results are reported in picocuries per liter (pCi/L).

Column Q is defined as the final data validator qualifier.

Column 2S is defined as the total uncertainty in the result (i.e., 2 standard deviations).

Column MDC is defined as the minimum detectable concentration.

U = The reported value is below the MDC and is considered to be a non-detect result.

UJ = The reported value is below the achievable MDC and is considered to be a non-detect result, but the required MDC was not attained.

J = The result is an estimated quantity.

YELLOW HIGHLIGHT Indicates measured unadjusted concentrations above MDCs which also equal or exceed a value 2 standard deviations above the mean site-specific background cocentration.

BOLDFACE TYPE Indicates unadjusted detections 2 standard deviations above background that also exceed the HRS Level I benchmark.

TABLE 3

WATER-SUPPLY-WELL ANALYTICAL RESULTS – PHASE 2 SAMPLING (JUNE 2017)

CANADIAN RADIUM AND URANIUM CORP. – SITE REASSESSMENT

DCN: W0428.1A.01313

Location: Field Sample ID: Date: Comments:	Bedford Rd Apts Well 1 0428-WSW03-02 6/28/2017				Bedford Rd Apts Well 2 0428-WSW04-02 6/28/2017				Criteria for Significance above Background *			Deer Ridge Well 1 0428-WSW01-02 6/27/2017				Deer Ridge Well 2 0428-WSW02-02 6/27/2017								NWPP 101 0428-WSW05-02 6/27/2017				NWPP 103-105 0428-WSW07-02 6/27/2017				HRS Benchmarks	
	Site-Specific Background (SSBG)				Site-Specific Background (SSBG)							–								Field Duplicate of 0428- WSW02-02												Minimum Value	Source
Radioisotope	Result	Q	Unc.	MDC	Result	Q	Unc.	MDC				Result	Q	Unc.	MDC	Result	Q	Unc.	MDC	Result	Q	Unc.	MDC	Result	Q	Unc.	MDC	Result	Q	Unc.	MDC		
Potassium (ug/L)	3,870		n/a	500	4,010		n/a	500	4,010	n/a	12,030	6,210		n/a	500	4,650		n/a	500	4,640		n/a	500	12,200		n/a	500	5,880		n/a	500	n/a	n/a
Radon (pCi/L)	1,491		274	46.3	1,108		206	46.3	1,299.5	274	1573.5	369.1		79.6	53.3	793		153	53.6	772		149	55.1	1,675		309	56.0	1,949		358	55.8	n/a	n/a
Radium-226 (pCi/L)	0.519		0.279	0.101	0.677		0.331	0.108	0.598	0.331	0.929	0.503		0.253	0.0853	0.271	0.3UJ	0.191	0.0919	0.815	J	0.369	0.110	0.364		0.219	0.0897	0.594		0.299	0.101	0.135	CRSC
Radium-228 (pCi/L)	0.960		0.438	0.732	1.42		0.503	0.723	1.19	0.503	1.693	1.37		0.516	0.772	0.475		0.336	0.647	0.0758		0.285	0.645	1.93		0.573	0.694	0.535		0.396	0.774	0.0502	CRSC
Total Radium (pCi/L; calculated)	1.479		0.717	0.833	2.097		0.834	0.831	1.788	0.834	2.622	1.873		0.769	0.8573	0.746		0.527	0.7389	0.8908		0.654	0.755	2.294		0.792	0.7837	1.129		0.695	0.875	n/a	n/a
Total Uranium (ug/L)	0.282		0.009	0.193	0.177		0.007	0.193	0.2295	0.009	0.6885	0.192		0.007	0.193	0.188	J	0.006	0.193	0.235	J	0.008	0.193	4.26		0.106	0.193	0.816		0.024	0.193	4	NCRSC
Uranium-234 (pCi/L)	0.224		0.171	0.241	0.250		0.166	0.227	0.237	0.171	0.408	0.246		0.158	0.143	0.237	J	0.168	0.143	0.083	J	0.108	0.206	1.63		0.427	0.102	0.605		0.242	0.167	0.739	CRSC
Uranium-235 (pCi/L)	0.231		0.174	0.089	0.057		0.097	0.134	0.144	0.174	0.318	0.115		0.122	0.153	0.133		0.156	0.249	0.048		0.101	0.146	0.190		0.142	0.072	0.048		0.097	0.135	0.727	CRSC
Uranium-238 (pCi/L)	0.019		0.091	0.126	0.057		0.074	0.102	0.038	0.091	0.129	0.213		0.147	0.139	0.101		0.115	0.170	0.049		0.079	0.156	1.22		0.356	0.102	0.208		0.136	0.123	0.60	CRSC
Gross Alpha (pCi/L)	2.82		0.761	0.628	3.63		0.972	0.919	3.225	0.972	4.197	1.92		0.750	0.914	0.994		0.441	0.610	0.723		0.402	0.618	8.82		3.75	5.17	4.19		2.29	2.97	n/a	n/a
Gross Beta (pCi/L)	3.32	J+	0.750	0.602	3.59	J+	0.801	0.624	3.455	0.801	4.256	3.23	J+	0.900	1.04	2.76	J+	0.664	0.640	3.21	J+	0.718	0.568	6.46	J+	2.59	3.80	2.77	J+	1.19	1.74	n/a	n/a

* For radionuclides, the criterion for significance above background = mean site-specific background + highest uncertainty (2 standard deviations). For Potassium and Total Uranium, the criterion for significance above background = 3x maximum background.

Column Q is defined as the final data validator qualifier.

Column Unc. is defined as the total uncertainty in the result (i.e., 2 standard deviations).

Column MDC is defined as the minimum detectable concentration.

YELLOW HIGHLIGHT Indicates unadjusted measured concentrations which also equal or exceed a value 2 standard deviations above the mean site-specific background cocentration.

BOLDFACE TYPE Indicates unadjusted detections above background that also exceed the HRS Level I benchmark.

**DATA VALIDATION REPORT:
DECEMBER 2016 SAMPLING EVENT**

DATE: March 17, 2017

SUBJECT: Radiochemical data validation for NAREL Sample Delivery Group 1600054 in regards to Canadian Radium Site, Mount Kisco, Westchester County, New York, revision 0

FROM: Rick Haaker; CHP, CIH, Chemist

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DCN: W0428.4B.01257, Revision 2

Associated TDD: 0004/1611-05

Contents

1	OVERVIEW	3
2	INTRODUCTION.....	4
2.1	DATA VALIDATION PRECAUTIONS AND LIMITATIONS.....	4
2.2	Chain of Custody Remarks.....	4
3	DATA QUALIFIERS	5
3.1	Final Data Qualifiers.....	5
3.2	Preliminary or Intermediate Data Qualifiers	5
4	EQUATIONS.....	7
4.1	Duplicate error ratio	7
4.2	Relative Percent Difference.....	7
4.3	Matrix Spike Percent Difference.....	7
4.4	Matrix Spike Normalized Difference.....	7
5	SAMPLE HANDLING AND ANALYSIS EVALUATION.....	7
5.1	Sample Descriptors (MARLAP 8.5.1.1).....	8
5.2	Aliquot Size (MARLAP 8.5.1.2)	8
5.3	Dates of Sample Collection, Preparation, and Analysis (MARLAP 8.5.1.3).....	8
5.4	Preservation (MARLAP 8.5.1.4)	9
5.5	Tracking (MARLAP 8.5.1.5)	9
5.6	Traceability (MARLAP 8.5.1.6)	9
5.7	QC Types and Linkages (MARLAP 8.5.1.7)	9
5.8	Chemical Separation (Yield) (MARLAP 8.5.1.8).....	10
5.9	Self-Absorption (MARLAP 8.5.1.9).....	10
5.10	Efficiency, Calibration Curves, and Instrument Background (MARLAP 8.5.1.10)	10
5.11	Spectrometry Resolution (MARLAP 8.5.1.11).....	11
5.12	Dilution and Correction Factors (MARLAP 8.5.1.12)	11
5.13	Counts and Count Time (Duration) (MARLAP 8.5.1.13)	11
5.14	Result of Measurement, Uncertainty, Minimum Detectable Concentration, and Units (MARLAP 8.5.1.14).....	12
6	QUALITY CONTROL SAMPLES TECHNICAL REVIEW.....	12
6.1	Method Blanks (MARLAP 8.5.2.1).....	12
6.2	Laboratory Control Samples (MARLAP 8.5.2.2).....	13
6.3	Laboratory Replicates (MARLAP 8.5.2.3).....	13

6.4	Matrix Spikes and Matrix Spike Duplicates (MARLAP 8.5.2.4)	13
6.5	Field Replicate Sample Performance	14
6.6	Rinse Blank Sample Performance	15
7	TEST OF DETECTION AND UNUSUAL UNCERTAINTY EVALUATION	16
7.1	Detection (MARLAP 8.5.3.1 and 8.5.3.2)	16
7.2	Large or Unusual Uncertainty (MARLAP 8.5.3.3).....	16
8	SUMMARY OF DATA USABILITY	17
9	REFERENCES.....	17
10	APPENDED DOCUMENTS.....	18

1 OVERVIEW

This report addresses the following data packages that were analyzed by National Analytical Radiation Environmental Laboratory in Montgomery, AL.

Table 1: Chain of Custody No. NAREL Sample Delivery Group.

NAREL Sample Delivery Group #	Chain of Custody #
1600054	2-120616-155527-0001

The NAREL reports for this set of samples are not like typical CLP Level 4 data packages. Some of the information that is found in Level 4 packages was not provided. The analytes (isotopes) that were reported and the methods used are provided in the following table.

Table 2: Isotopes Reported and Analytical Methods.

Method	Isotopes
NAREL GAM-01	Bi207, Bi212, Bi214, Cs137, K40, Pb210, Pb212, Pb214, Ra226, Ra228, Th234, Tl208
NAREL GR-01	Alpha, Beta
NAREL RA226-EICHROM	Ra226
NAREL TH-EICHROM	Th227, Th228, Th230, Th232
NAREL U-EICHROM	U234,U235,U238

2 INTRODUCTION

Seven water samples were collected at the site on December 6, 2016. The following tables provide information on which samples were analyzed by the various analytical methods. The samples were submitted under one "Chain of Custody." PNAREL reported the results in a brief pdf format data report. Each report provided analytical results, chain of custody, case narrative, but no raw data. An electronic data deliverables (EDD) was provided, which contained analytical results as well as information that was useful in assigning data qualifiers in a readily accessible format.

The radio-analytical data were validated to the requirements of the quality assurance project plan (QAPP) ¹ and to the Multi-Agency Radiological Laboratory Analytical Protocols Manual (MARLAP) *Chapter 8 - Radiochemical Data Verification and Validation*². The QAPP requirements took precedence in instances where there was a conflict between the QAPP and MARLAP. The depth of the validation was necessarily limited because Derived Concentration Guidelines (DCGL), and some specific data performance requirements have not been designated.

2.1 DATA VALIDATION PRECAUTIONS AND LIMITATIONS

It should be noted that this technical report describes method validation and is not intended to provide guidance for validation of overall program/project objectives and requirements. Project validation is generally performed by project management personnel and involves a comprehensive review of all aspects (and objectives) of a sampling and analysis project.

Table 3: Cross Reference of Weston sample ID (ClientID) and Laboratory Internal ID (NAREL ID)

ClientID	NAREL ID
0428-WSW01	B6.12114X
0428-WSW02	B6.12115Y
0428-WSW03	B6.12116Z
0428-WSW04	B6.12117A
0428-WSW05	B6.12118B
0428-WSW06	B6.12119C
0428-WSW07	B6.12120V

Samples 0428-WSW02 and 0428-WSW06 are field replicate samples.

2.2 Chain of Custody Remarks

Sample shipments to NAREL observed normal chain of custody and sample preservation procedures and no exceptions were noted. There is not a receipt inspection log, but there is a remark on the chain of custody indicating that the sample condition upon receipt was good. The lab reported results for

¹ Uniform Federal Policy – Quality Assurance Project Plan, DCN: W0428.1E.01181, TDD No.: 0004/1611-05, Canadian Radium & Uranium Contract No.: EP-S8-13-01 (Region 8 START IV), Prepared for US EPA Region 2, December 2016.

² Multi-Agency Radiological Laboratory Analytical Protocols Manual, Volume I, NUREG-1576, EPA 402-B-04-001A, NTIS PB2004-105421, July 2004.

each sample listed on the Chain of Custody and there was no evidence that the shipment contained extra samples that were not on the Chain of Custody.

No data qualifiers were assigned on the basis of these chain of custody discrepancies.

3 DATA QUALIFIERS

3.1 Final Data Qualifiers

Final Data qualifiers are codes placed on an analytical result that alert data users to the validator's concern about the result. These qualifiers may be summarized as U, J, R, or Q in the final validation report.

None The analysis was performed and radioactivity was detected. The result is statistically positive at the 95% confidence level, above the critical level and above the minimum detectable concentration (MDC). The radionuclide is considered to be present in the sample.

U A normal, not detected (< critical value) result.

UJ The analyte was not detected, but the required MDC was not attained. A number of specific problems also resulted in assignment of a J qualifier where results were more uncertain than usual.

Q A reported combined standard uncertainty, which exceeds the project's required method uncertainty. (In this report Q was only used as an intermediate or preliminary qualifier.)

J An unusually uncertain or estimated result.

R A rejected result: the problems (quantitative or qualitative) are so severe that the data cannot be used.

The data validator should incorporate the project quality objectives from the QAPP into the testing and qualifying decision-making process.

3.2 Preliminary or Intermediate Data Qualifiers

During the data validation process the data validator may use additional qualifiers based on quality control (QC) sample results and acceptance criteria. The final validation reports should also include a summary of QC sample performance for use by the data assessor. Intermediate or preliminary qualifiers, such as 'S', 'B' or 'P' are assigned on the basis of QC sample performance and these are taken into consideration in assignment of a final qualifier to an analytical result.

E An "E*" means that something is non-compliant with a MARLAP requirement, or is typically provided in level 4 packages but is absent from the package, or cannot be determined from the information provided. The * is a second alphabetic character that describes the particular aspect of the data issue. For example, "EA" represents a result for which no aliquot information is provided. An intermediate "E*" qualifier may not be based on a QAPP requirement, and by itself does not lead to assignment of a final qualifier.

J1+ A result for a sample whose associated blank contained detected activity above the critical level and the result for the sample was less than 5 times the result for the blank.

S A result with a related spike result (laboratory control sample [LCS], matrix spike [MS] or matrix spike duplicate [MSD]) that is outside the control limit for recovery (%R); S+ or S- used to indicate high or low recovery.

P A result with an associated replicate result that exceeds the control limit or Z value greater than 3.

P1 A result for a particular analyte and sample that has associated with it a relatively poorly performing pair of field replicates, which have a duplicate error ratio or Z value greater than 3.

B A result with associated blank result, which is outside the control limit, B+ or B- used to indicate high or low results.

M An alpha spectroscopy result whose alpha spectra clearly appear to be affected by mass attenuation resulting in loss of counts from regions of interest.

The logic for mapping preliminary data qualifiers to final data qualifiers is provided in the next table. Each sample result has only one final data qualifier, but may have several preliminary or intermediate data qualifiers that represent aspects of data quality. Sixteen intermediate data qualifiers, each delimited by a comma, are given in the final table in a column entitled “Intermediate Qualifier Summary” in the following order:

- Blank Qualifier
- Spike Qualifier
- Intermediate Detection Qualifier
- Field Duplicate Qualifier
- Lab Duplicate Qualifier
- Rinse Blank Qualifier
- Tracer Recovery Qualifier
- Mass Attenuation Qualifier
- Aliquot Qualifier
- Ingrowth Qualifier
- Detector Tracking Qualifier
- NIST Qualifier
- Efficiency Qualifier
- Resolution Qualifier
- Mass Attenuation Qualifier
- Count Time Qualifier
- Dilution Qualifier.

The “Mass Attenuation Qualifier” appears in this list twice to maintain consistency with another water sample data package concerning this site, RST3-03-F-0052, Revision 0, and dated February 13, 2017

Table 4: Preliminary (intermediate) and final data qualifiers for this dataset.

Intermediate Qualifier Summary	Final Qualifier
,,,,,EM,,,,EN,EE,,EM,,EZ	--
,,,,,EM,,,,EN,EE,ER,EM,,	--
,,,,,EM,,,,EN,EE,ER,EM,,EZ	--
,,,,,EM,,J,,EN,EE,ER,EM,,	J
,,,P1,,,,EM,,,,EN,EE,,EM,,EZ	J
,,U,,,,EM,,,,EN,EE,,EM,,EZ	U
,,U,,,,EM,,,,EN,EE,ER,EM,,	U
,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U

Intermediate Qualifier Summary	Final Qualifier
„U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ
„UJ,,,,,EM,,,,,EN,EE,,EM,EC,EZ	UJ
„UJ,,,,,EM,,,,,EN,EE,R,EM,EC,	R

4 EQUATIONS

The following equations are frequently used to compare the performance of pairs of aliquots that were drawn from the same sample.

4.1 Duplicate error ratio

The duplicate error ratio (DER, also known as Z-score) is the relative error in a pair of measurements and takes into account the measurement results, Ma and Mb, as well as the standard errors associated with the measurements, 2Sa and 2Sb.

By convention, laboratories report analytical errors as 2 times the standard deviation, 2 Sa and 2 Sb. If Ma and Mb are results from duplicate aliquots that were taken from a homogeneous sample, then 95% of the time the DER is expected to be less than 1.96 and 99% percent of the time it is expected to be less than 2.58 , provided that the errors are normally distributed.

$$DER = 2 \times \frac{Abs(Ma - Mb)}{\sqrt{(2 Sa)^2 + (2 Sb)^2}}$$

4.2 Relative Percent Difference

The relative percent difference (RPctD) is a measure of consistency of measured concentration between two aliquots of a sample.

$$RPctD = 200\% \times \frac{Abs(Ma - Mb)}{Ma + Mb}$$

4.3 Matrix Spike Percent Difference

$$MSPctD = 100\% \times \frac{Spike Result - Unspiked Result}{Spike}$$

4.4 Matrix Spike Normalized Difference

$$MSND = 2 \times \frac{Spike Result - Unspiked Result - Spike}{((2 S_{Spike Result})^2 + (2 S_{Unspiked Result})^2 + (2 S_{Spike Result})^2)^{0.5}}$$

Ninety-five percent of the time the absolute value of the matrix spike normalized difference is expected to be less than 1.96, and 99% of the time it should be less than 2.58.

5 SAMPLE HANDLING AND ANALYSIS EVALUATION

This section contains the technical review comments describing the findings and observations for each

of the main verification and validation parameters described in MARLAP Chapter 8 - Radiochemical Data Verification and Validation.

5.1 Sample Descriptors (MARLAP 8.5.1.1)

Each sample should have a unique identification code that can be cross-referenced to a unique laboratory identification number.

Discussion

The laboratory identification numbers were listed in the cover page/case narrative in the data packages along with client ID numbers for all field samples.

No data qualifiers were assigned on sample descriptors.

5.2 Aliquot Size (MARLAP 8.5.1.2)

The aliquot or sample size used for analysis should be documented so that it can be checked when reviewing calculations, examining dilution factors or analyzing any data that requires aliquant as an input. It is also imperative that the appropriate unit (liter, kilogram, etc.) is assigned to the aliquant.

Discussion

The aliquot sizes as well as their units were provided in the laboratory data packages or the EDD.

No data qualifiers were assigned on this basis.

5.3 Dates of Sample Collection, Preparation, and Analysis (MARLAP 8.5.1.3)

The analytical data package should report date of sampling, preparation, and analysis. These data are used to calculate radiological holding times, some of which may be specified in the Field Sampling Plan.

Discussion

Data were provided and the holding time requirements (i.e. <6 months) were met for every analysis in the data package. No issues of this type were recognized and no qualifiers were assigned on the basis of holding time exceedances.

Any gamma spectroscopy procedure requires an ingrowth time on the order of 21 days to ensure that radon-222 is in secular equilibrium with radium-226 before the sample is counted. This ingrowth time begins on the day the sample is prepared and sealed into a container and ends when the sample is counted in a gamma spectrometer. The sample preparation /sealed date is not provided for gamma spec samples in the pdf report or in the EDD.

Since the ingrowth time is not stated, the reported concentrations of lead-214 and bismuth-214 are more uncertain than usual and possibly could have a high or a low bias. Lead and bismuth-214 results were assigned a "J" ingrowth intermediate qualifier based on professional judgement and on NAREL's assessment that the concentrations reported for these nuclides may be affected by radon-222 loss from the sample container.

5.4 Preservation (MARLAP 8.5.1.4)

Appropriate preservation is dependent upon analyte and matrix and should be defined in sampling and analysis documentation. These requirements are stated in the draft QAPP, Worksheet 19.

Discussion

The QAPP states that aqueous samples, such as rinse blanks, are to be preserved by acidification with nitric acid. The preservation stated on the Chain of Custody was HNO₃, pH < 2 and the Chain of Custody indicates that the samples were received in “Good” condition.

Overall, it appears that the preservation conditions were consistent with QAPP requirements for the samples. No qualifiers were assigned on this basis.

5.5 Tracking (MARLAP 8.5.1.5)

Each analytical result should be linked to the instrument or detector on which it was counted.

Discussion

The specific detectors that were used for a particular sample could be surmised from the information provided in the data packages as required by MARLAP. No samples were issued a final qualifier on the basis of missing detector information.

5.6 Traceability (MARLAP 8.5.1.6)

The traceability of standards and reference materials to be used during the analysis should be specified in the Field Sampling Plan.

Discussion

The Field Sampling Plan did not provide specific requirements for traceability. There is not documentation that all radioactive standards are directly or indirectly traceable to NIST. Thus an intermediate traceability qualifier of ‘EN’ was assigned to each result to alert users that information was missing that is normally provided in Level 4 data packages. No final qualifiers were assigned on this basis because it is not a directly stated requirement in the QAPP.

5.7 QC Types and Linkages (MARLAP 8.5.1.7)

The type and quantity of QC samples should be identified and listed in the SOW and the results provided by the laboratory in a summary report. Replicates and matrix spike results should be linked to the original sample results.

The information obtained from the analysis of laboratory-generated duplicates is useful to evaluate analytical variability and laboratory precision. Results from the analysis of laboratory-generated duplicate samples can also reflect the homogeneity or inhomogeneity of individual samples or groups of samples of the same matrices.

Discussion

The QAPP did not require matrix spike and matrix spike duplicates for water samples. In addition the QAPP is ambiguous about the number of matrix spike and matrix spike duplicates that are required per QA batch.

There were blank, laboratory control standard (LCS), matrix spike (MS), and laboratory duplicates in

the lab reports. Field samples 0428-WSW02 and 0428WSW06 are field replicate samples.

No deficiencies were recognized and no qualifiers were assigned on the basis of QC types and linkages as a consequence.

5.8 Chemical Separation (Yield) (MARLAP 8.5.1.8)

Yield assesses the effects of the sample matrix and the chemical separation steps on the analytical result and estimates the analyte loss throughout the total analytical process.

The evaluation of an analytical yield serves to evaluate the efficiency of radiochemical separations utilized when preparing samples for measurement or analysis. The use of a tracer is conducted when a known amount of a chemical tracer is added to unknown samples; during analysis, a yield or recovery of the tracer material is used to determine the efficiency of the entire analytical process. The tracer that is chosen is used because it mimics the properties of one or more target radionuclides. A tracer refers to a radioactive isotope, while a carrier is a non-radioactive substance.

Discussion

Insufficient information was provided to permit the yields to be recalculated. Also, the QAPP does not provide yield acceptance criteria. None of the reported tracer recoveries or chemical yields for field samples or QC samples were unreasonably high or low. No qualifiers were assigned on the basis of tracer recovery.

5.9 Self-Absorption (MARLAP 8.5.1.9)

For some radiochemical analytical methods, the SOW may specify the generation of a self-absorption curve, which correlates mass of sample deposited in a known geometry to detector efficiency.

Discussion

None of the information required to assess self-absorption was provided. Therefore all sample results other than those obtained by NAREL GAM-01 were assigned an intermediate “EM” absorption qualifier, which is a caution to data users that some information concerning mass attenuation that is usually provided in level 4 data packages was missing.

No final data qualifiers were assigned as a result of self-absorption issues.

5.10 Efficiency, Calibration Curves, and Instrument Background (MARLAP 8.5.1.10)

The determination of detector efficiency is a detailed process that is best checked during an audit of the laboratory’s capabilities and is usually not part of the verification and validation process.

Discussion

No documentation was provided in each data package that the equipment used was calibrated or that the efficiencies of the detectors were well determined.

On the other hand, the laboratory data package QA narratives did not identify any deficiencies related to calibration curves, efficiency and instrument backgrounds. An “EE” efficiency qualifier was assigned to each result, which is a caution to data users that some information concerning efficiency, calibration curves and instrument background that is usually provided in level 4 data packages was missing.

No final data qualifiers were assigned as a result of missing efficiency, calibration curves and

instrument background.

5.11 Spectrometry Resolution (MARLAP 8.5.1.11)

The measured resolution of alpha and gamma spectrometers, and spectral information should be provided in the data package to evaluate if proper peak identification and separation was made.

Discussion

The data package does not provide FWHM data or any spectrometry resolution data.

There is a well-known interference between radium-226 and uranium-235 by gamma spectroscopy since both have gamma emissions at 186 KeV and the spectrometer resolution is typically insufficient to resolve the contributions of the respective isotopes.

Radium-226 results from gamma spectroscopy (NAREL GAM-01) were rejected as unreliable because of a possible interference with uranium-235, and radium-226 was reported by other methods that are more reliable in this data package.

Due to the lack of spectrometry resolution data, all other results from NAREL GAM-01, NAREL TH-EICHROM and NAREL U-EICHROM were assigned an intermediate resolution qualifier of "ER" which is a caution to data users that some information like spectra and resolution data that is usually provided in level 4 data packages was missing.

Other than the radium-226 results by gamma spectroscopy, no final qualifiers were assigned on the basis of spectral resolution data.

5.12 Dilution and Correction Factors (MARLAP 8.5.1.12)

Samples for radiochemistry are usually not diluted. If required, dilution and correction factors (i.e., dry weight correction, ash weight correction) should be provided in the data package so that the final calculations of all data affected by dilution factors can be recalculated and confirmed.

Discussion

Details on the dilutions performed on standards and samples were not provided in the data package. Due to the lack of data, all results except those from NAREL GAM-01 were assigned an intermediate dilution qualifier of "EZ" which is a caution to data users that some information like dilution and correction factors that is usually provided in level 4 data packages was missing.

No final qualifiers were assigned on this basis.

5.13 Counts and Count Time (Duration) (MARLAP 8.5.1.13)

The count time for each sample, QC analysis, and instrument background should be recorded in the data package. The ability to detect radionuclides is directly related to the count time.

Discussion

Results were assigned an intermediate count time qualifier of "EC" only where all of the following conditions were satisfied:

- MDC > required MDC (RMDC),
- MDC > Result,
- Units = 'pCi/L', and

- RMDC was specified in the QAPP worksheet 15.

Results with an intermediate count time qualifier always carry a 'UJ' final qualifier unless they were rejected for some other reason.

5.14 Result of Measurement, Uncertainty, Minimum Detectable Concentration, and Units (MARLAP 8.5.1.14)

The result of each measurement, its expanded measurement uncertainty, and the estimated sample- or analyte-specific MDC should be reported for each sample in the appropriate units.

Discussion

Radium-226 results by NAREL GAM01 were rejected with a resolution qualifier of 'R' because there tends to be a spectral interference with uranium-235. Gamma spectroscopy lacks the sensitivity required for water samples, although in many cases no RMDC was specified in the QAPP for isotopes determined by this method.

The results of each measurement, its expanded measurement uncertainty, and the estimated sample- or analyte-specific MDC were reported along with the units of measure. No qualifiers were assigned on this basis. The blank results were reported in units that were inconsistent with field sample results as discussed in section 6.1.

6 QUALITY CONTROL SAMPLES TECHNICAL REVIEW

6.1 Method Blanks (MARLAP 8.5.2.1)

The requirement for a method blank is usually established in the SOW and appropriate plan documents. Check to see if a method blank was analyzed and no detected concentration/activity found in the results.

Discussion

"Method blank" results were provided for every analyte in the data package, but the results were reported in units of "pCi" instead of the normal "pCi/L." No activity was reported in any blank at concentrations that exceeded the minimum detectable concentration, except as noted in the table below. If no qualifier value is provided for a method blank, then the analyte of interest was reported as detected above the MDC. The Required MDC values stated in QAPP worksheet 15 are in units of pCi/L and cannot be compared to results for assessment of bank performance based on information in the packages.

Normally, a blank qualifier value of 'J+' for a field sample would mean that the analyte was detected in the associated method blank, but at a concentration less than three times the result reported for the blank. Since the units were inconsistent, no final qualifiers could be assigned on the basis of blank / background performance.

Table 5: Method blank or background QC result having activity greater than the MDC.

NARELID	QCType	Method	Analyte	Result (pCi)	MDC (pCi)
RBK-00744613K	RBK	NAREL RA226-EICHROM	Ra226	0.0187	0.0156

6.2 Laboratory Control Samples (MARLAP 8.5.2.2)

Laboratory control samples (LCS), but no and LCS duplicates (LCSD) were run for each batch and analysis type. LCSD samples were not required by the QAPP. Insufficient information was provided to allow the percent recoveries to be recalculated for any LC sample. NAREL reports a Z value, which should be a measure of the normalized difference between the measured and known values in units of standard deviations.

All Z values reported for LCS samples were acceptable and no qualifiers were assigned on the basis of poor spike recovery.

6.3 Laboratory Replicates (MARLAP 8.5.2.3)

The objective of replicate analyses are to measure laboratory precision based on each sample matrix. Check to see if laboratory replicate was analyzed and within control limits.

Discussion

One duplicate sample 0428-WSW07 had an apparently erroneous (very large) uncertainty term reported for bismuth-212, and this artificially reduced the duplicate error ratio or Z value to nearly zero for that analyte. Replicate performance was acceptable for all other samples, with no duplicate error ratio exceeding 1.96 times the standard error. The performance criteria is that the duplicate error ratio should be less than three for each result.

No preliminary or final qualifiers were assigned on the basis of discrepant laboratory replicate results.

6.4 Matrix Spikes and Matrix Spike Duplicates (MARLAP 8.5.2.4)

Matrix spike (MS) samples provide information about the effect of each sample matrix on the preparation and measurement methodology. The test uncovers the possible existence of recovery problems, based on either a statistical test or a specified fixed control limit.

Discussion

There appears to be no requirement for MS duplicates in the QAPP for water samples. In addition there are no performance criteria in the QAPP for MS. There were MS for all methods except gamma spectroscopy and laboratories typically do not perform matrix spikes on gamma spectroscopy samples. The MS data were only provided in the EDDs for the gross alpha/beta method. None of the MS QC samples exhibited unacceptable chemical yield or spike recoveries.

No qualifiers were assigned on the basis of their performance since these were not required QC samples.

6.5 Field Replicate Sample Performance

Field replicates or duplicates are given in the following table. In this table, 'Two S' represents 2 times the combined standard uncertainty.

Table 6: Field replicate samples.

Client ID 1	Client ID 2	Method	Analyte	Conc1	Conc2	Two S1	Two S2	Dup Error Ratio
				(pCi/L)				(Z score)
0428-WSW02	0428-WSW06	NAREL GR-01	Alpha	4.11	1.81	6.23	7.61	0.47
0428-WSW02	0428-WSW06	NAREL GR-01	Beta	11.2	12.2	3.47	6.29	0.28
0428-WSW02	0428-WSW06	NAREL GAM-01	Bi212	1.35	-0.348	7.48	13.9	0.22
0428-WSW02	0428-WSW06	NAREL GAM-01	Bi214	1.43	-0.241	1.21	1.32	1.87
0428-WSW02	0428-WSW06	NAREL GAM-01	Cs137	-0.144	-0.438	0.577	0.607	0.7
0428-WSW02	0428-WSW06	NAREL GAM-01	K40	3.41	4.15	8.13	8.73	0.12
0428-WSW02	0428-WSW06	NAREL GAM-01	Pb210	-4.46	-0.349	24.4	13.3	0.3
0428-WSW02	0428-WSW06	NAREL GAM-01	Pb212	0.721	0.797	1.11	1.08	0.1
0428-WSW02	0428-WSW06	NAREL GAM-01	Pb214	0.598	-0.439	1.41	2.3	0.77
0428-WSW02	0428-WSW06	NAREL GAM-01	Ra226	-3.73	11.5	11.4	13	1.76
0428-WSW02	0428-WSW06	NAREL GAM-01	Ra228	2.39	2.85	2.04	2.05	0.32
0428-WSW02	0428-WSW06	NAREL GAM-01	Th234	-10.3	4.89	14.5	15.5	1.43
0428-WSW02	0428-WSW06	NAREL GAM-01	Tl208	-0.145	-0.265	0.998	1.54	0.13
0428-WSW02	0428-WSW06	NAREL RA226-EICHROM	Ra226	1.14	0.309	0.352	0.147	4.36
0428-WSW02	0428-WSW06	NAREL TH-EICHROM	Th227	0.0803	-0.00832	0.109	0.0552	1.45
0428-WSW02	0428-WSW06	NAREL TH-EICHROM	Th228	0.0101	0.117	0.0668	0.102	1.75
0428-WSW02	0428-WSW06	NAREL TH-EICHROM	Th230	0.178	0.0857	0.174	0.155	0.79
0428-WSW02	0428-WSW06	NAREL TH-EICHROM	Th232	0.0302	0	0.0534	0.0297	0.99
0428-WSW02	0428-WSW06	NAREL U-EICHROM	U234	0.319	0.368	0.17	0.147	0.44
0428-WSW02	0428-WSW06	NAREL U-EICHROM	U235	0.0312	0.0319	0.0856	0.0564	0.01
0428-WSW02	0428-WSW06	NAREL U-EICHROM	U238	0.215	0.239	0.138	0.118	0.26

The relative percent differences (R%D) were calculated for the field duplicate pairs of samples. This statistic potentially can provide indications of the uniformity of the analyte in the media sampled. More often, high values of relative percent difference arise from when individual analytical results themselves are rather uncertain. Duplicate error ratios greater than 1.96 times the standard error suggest that a pair of results are significantly more discrepant than usual. The more discordant field duplicates are provided in the table below.

Table 7: Relatively discrepant field replicate results.

Client ID 1	Client ID 2	Method	Analyte	Conc1	Conc2	Two S1	Two S2	R%D	Dup Error Ratio
				pCi/L					(Z score)
0428-WSW02	0428-WSW06	NAREL RA226-EICHROM	Ra226	1.14	0.309	0.352	0.147	115	4.36

Sample results that are associated with the poorly performing field replicate samples carry an intermediate field replicate qualifier of 'P1' in the final data table. The final qualifier assigned to field samples involving the impacted analyte are at best a 'J' qualified.

6.6 Rinse Blank Sample Performance

There were no rinse blank duplicates in this data package. According to Mr. Gerald Gilliland (Weston Solutions), no sampling hardware was re-used during the sampling campaign as it was possible to collect the media directly into the sample containers.

7 TEST OF DETECTION AND UNUSUAL UNCERTAINTY EVALUATION

7.1 Detection (MARLAP 8.5.3.1 and 8.5.3.2)

The general list of data qualifiers is provided in Section 3 and there is a consolidated table of analytical results with qualifiers in Section 10 of this report. The Intermediate Qualifier Summary field provides information on seventeen aspects of data quality, and the qualifiers for each aspect are delimited by a comma. The information in the third of these comma separated fields is specific to detection.

Discussion

The detection qualifier is assigned using the following contingency table. Based on the relative values of MDC, RMDC and Result.

Table 8: Contingency table of intermediate detection qualifiers.

	RMDC \geq MDC	RMDC < MDC	RMDC not defined
Result \geq MDC	--	--	--
Result < MDC	U	UJ	U,

Table 9: Intermediate detection qualifiers.

Intermediate Detection Qualifier	Explanation
,	A result that was reported to be greater than the MDC without obvious interference. This is the symbol for “no data qualifier needed to be assigned.”
U,	A result that was reported to be less than the MDC and also less than the RMDC if one was specified in the QAPP.
UJ,	A result that was reported to be less than the associated MDC but greater than the RMDC stated in the QAPP.

To keep the length of this report to a minimum, the list of sample results that carry a detection qualifier is not provided in this section.

The RMDC values were specified in the QAPP Worksheet 15 for many isotopes. The NAREL documentation does not identify the RMDC for any methods or analytes. Nineteen results for field samples have intermediate detection qualifiers of “UJ” where no activity was detected but the required detection limit was not attained.

7.2 Large or Unusual Uncertainty (MARLAP 8.5.3.3)

When method blanks have detected activity, the analytical results for associated samples may be more uncertain than usual.

Discussion

Sample results are normally assigned a blank qualifier that included the characters 'B+' if activity was detected in a blank and an associated sample result was less than 3 times the blank result. The blank qualifiers would be denoted by the characters ending with the first comma in the intermediate qualifier summary. Since the units for the 'blank' and sample results were different, they could not be directly compared.

No sample results could be assigned a blank qualifier.

8 SUMMARY OF DATA USABILITY

Of 168 field sample results, twenty-five did not carry a final data qualifier. The meaning of each final qualifier is described in section 3 of this report. The frequency of each final qualifier type for field samples is provided in the following table.

Table 10: Frequency of the final data qualifiers.

Final Qualifier	Frequency
--	25
J	10
R	8
U	106
UJ	19

The distribution of qualifiers among field samples is further broken down in the following table.

Table 11: Frequency of final data qualifiers by method.

Method	Final Qualifier	Frequency
NAREL GAM-01 (Gamma Spectroscopy)	--	2
	J	2
	R	8
	U	62
	UJ	14
NAREL GR-01 (Gross Alpha/Beta)	--	7
	U	4
	UJ	5
NAREL RA226-EICHROM (Radium-226)	J	8
NAREL TH-EICHROM (Isotopic Thorium)	--	2
	U	30
NAREL U-EICHROM (Isotopic Uranium)	--	14
	U	10

9 REFERENCES

Uniform Federal Policy – Quality Assurance Project Plan, DCN: W0428.1E.01181, TDD No.: 0004/1611-05, Canadian Radium

& Uranium Contract No.: EP-S8-13-01 (Region 8 START IV), Prepared for US EPA Region 2, December 2016.

Multi-Agency Radiological Laboratory Analytical Protocols Manual, Volume I, NUREG-1576, EPA 402-B-04-001A, NTIS PB2004-105421, July 2004.

10 APPENDED DOCUMENTS

Consolidated table of analytical results with qualifiers (7 pages).

Radiological Data Verification/Validation Checklist (2 pages).

Canadian Radium and Uranium Site

DCN: W0428.4B.01257, Revision 2

Client ID	Method	Analyte	NARELID	Matrix	Conc	2S	MDA	Intermediate Qualifier Summary	Final Qualifier	Units
0428-WSW01										
	NAREL GAM-01	Bi212	B6.12114X	WATER	-0.25	43.9	12.7	„U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Bi214	B6.12114X	WATER	4.87	1.42	1.81	,,,,,,EM,,J,,EN,EE,ER,EM,,	J	PCI/L
	NAREL GAM-01	Cs137	B6.12114X	WATER	-0.12	0.6	1	„U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12114X	WATER	5.4	8.82	11.1	„U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12114X	WATER	-4.14	23.2	22.4	„U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12114X	WATER	0.91	1.13	1.85	„U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb214	B6.12114X	WATER	3.52	1.45	2.01	,,,,,,EM,,J,,EN,EE,ER,EM,,	J	PCI/L
	NAREL GAM-01	Ra226	B6.12114X	WATER	9.28	13.3	22	„UJ,,,,,EM,,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra228	B6.12114X	WATER	3.38	2.02	3.16	,,,,,,EM,,,,,EN,EE,ER,EM,,	--	PCI/L
	NAREL GAM-01	Th234	B6.12114X	WATER	7.26	15.9	26.3	„U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12114X	WATER	-0.17	1.08	1.01	„U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GR-01	Alpha	B6.12114X	WATER	3.45	5.39	3.78	„U,,,,,EM,,,,,EN,EE,,EM,,EZ	U	PCI/L
	NAREL GR-01	Alpha	B6.12114X	WATER	3.47	5.58	4.31	„U,,,,,EM,,,,,EN,EE,,EM,,EZ	U	PCI/L
	NAREL GR-01	Beta	B6.12114X	WATER	9.3	3.32	4.31	,,,,,,EM,,,,,EN,EE,,EM,,EZ	--	PCI/L
	NAREL GR-01	Beta	B6.12114X	WATER	12.1	3.6	4.46	,,,,,,EM,,,,,EN,EE,,EM,,EZ	--	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12114X	WATER	1.07	0.3	0.13	„P1,,,,,EM,,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL TH-EICHROM	Th227	B6.12114X	WATER	-0.01	0.06	0.16	„U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12114X	WATER	0.17	0.12	0.15	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL TH-EICHROM	Th230	B6.12114X	WATER	0.01	0.14	0.28	„U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12114X	WATER	-0.02	0.04	0.12	„U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U234	B6.12114X	WATER	0.16	0.1	0.09	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U235	B6.12114X	WATER	0.02	0.05	0.09	„U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U238	B6.12114X	WATER	0.16	0.1	0.09	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
0428-WSW02										

Client ID	Method	Analyte	NARELID	Matrix	Conc	2S	MDA	Intermediate Qualifier Summary	Final Qualifier	Units
	NAREL GAM-01	Bi212	B6.12115Y	WATER	1.35	7.48	12.6	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Bi214	B6.12115Y	WATER	1.43	1.21	1.78	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Cs137	B6.12115Y	WATER	-0.14	0.58	0.97	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12115Y	WATER	3.41	8.13	10.8	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12115Y	WATER	-4.46	24.4	22.4	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12115Y	WATER	0.72	1.11	1.83	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb214	B6.12115Y	WATER	0.6	1.41	2.4	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Ra226	B6.12115Y	WATER	-3.73	11.4	18.9	,,UJ,,,,,EM,,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra228	B6.12115Y	WATER	2.39	2.04	3.28	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Th234	B6.12115Y	WATER	-10.3	14.5	23.9	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12115Y	WATER	-0.14	1	1.03	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GR-01	Alpha	B6.12115Y	WATER	4.11	6.23	4.26	,,U,,,,,EM,,,,,EN,EE,,EM,,EZ	U	PCI/L
	NAREL GR-01	Beta	B6.12115Y	WATER	11.2	3.47	4.36	,,,,,,EM,,,,,EN,EE,,EM,,EZ	--	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12115Y	WATER	1.14	0.35	0.12	,,,P1,,,,,EM,,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL TH-EICHROM	Th227	B6.12115Y	WATER	0.08	0.11	0.13	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12115Y	WATER	0.01	0.07	0.14	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th230	B6.12115Y	WATER	0.18	0.17	0.27	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12115Y	WATER	0.03	0.05	0.08	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U234	B6.12115Y	WATER	0.32	0.17	0.14	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U235	B6.12115Y	WATER	0.03	0.09	0.16	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U238	B6.12115Y	WATER	0.22	0.14	0.1	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
0428-WSW03										
	NAREL GAM-01	Bi212	B6.12116Z	WATER	0.25	7.92	13.4	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Bi214	B6.12116Z	WATER	0.24	1.23	2.16	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Cs137	B6.12116Z	WATER	0.13	0.54	0.92	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12116Z	WATER	-9.82	23.1	11.3	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12116Z	WATER	-2.8	18.8	22	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12116Z	WATER	0.8	1.08	1.78	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L

Client ID	Method	Analyte	NARELID	Matrix	Conc	2S	MDA	Intermediate Qualifier Summary	Final Qualifier	Units
	NAREL GAM-01	Pb214	B6.12116Z	WATER	0.74	1.45	2.09	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Ra226	B6.12116Z	WATER	5.2	13	21.6	,,UJ,,,,,EM,,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra228	B6.12116Z	WATER	1.81	1.98	3.24	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Th234	B6.12116Z	WATER	1.5	15.5	25.8	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12116Z	WATER	0.06	0.59	1.02	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GR-01	Alpha	B6.12116Z	WATER	1.17	4.17	3.32	,,U,,,,,EM,,,,,EN,EE,,EM,,EZ	U	PCI/L
	NAREL GR-01	Beta	B6.12116Z	WATER	7.42	3.26	4.34	,,,,,,EM,,,,,EN,EE,,EM,,EZ	--	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12116Z	WATER	0.65	0.23	0.13	,,,P1,,,,,EM,,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL TH-EICHROM	Th227	B6.12116Z	WATER	0	0.09	0.22	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12116Z	WATER	0.08	0.08	0.1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th230	B6.12116Z	WATER	0.13	0.17	0.28	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12116Z	WATER	0.02	0.06	0.11	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U234	B6.12116Z	WATER	0.2	0.11	0.1	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U235	B6.12116Z	WATER	0.09	0.09	0.11	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U238	B6.12116Z	WATER	0.09	0.08	0.1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
0428-WSW04										
	NAREL GAM-01	Bi212	B6.12117A	WATER	-0.64	23.7	12	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Bi214	B6.12117A	WATER	0.61	1.08	1.69	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Cs137	B6.12117A	WATER	-0.09	0.48	0.82	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12117A	WATER	-3.34	8.69	11	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12117A	WATER	2.77	11.5	18.1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12117A	WATER	0.92	1.1	1.8	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb214	B6.12117A	WATER	0.12	1.36	2.34	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Ra226	B6.12117A	WATER	4.94	12.8	21.2	,,UJ,,,,,EM,,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra228	B6.12117A	WATER	2.19	1.92	3.1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Th234	B6.12117A	WATER	-0.14	15.1	25.2	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12117A	WATER	-0.1	0.81	1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GR-01	Alpha	B6.12117A	WATER	4.82	4.82	3.25	,,,,,,EM,,,,,EN,EE,,EM,,EZ	--	PCI/L

Client ID	Method	Analyte	NARELID	Matrix	Conc	2S	MDA	Intermediate Qualifier Summary	Final Qualifier	Units
	NAREL GR-01	Beta	B6.12117A	WATER	7	3.22	4.33	,,,,,,EM,,,,EN,EE,,EM,,EZ	--	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12117A	WATER	0.65	0.22	0.12	,,,P1,,,,EM,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL TH-EICHROM	Th227	B6.12117A	WATER	-0.01	0.05	0.14	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12117A	WATER	0.1	0.09	0.11	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th230	B6.12117A	WATER	0	0.14	0.27	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12117A	WATER	0	0.03	0.08	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U234	B6.12117A	WATER	0.06	0.07	0.11	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U235	B6.12117A	WATER	0.01	0.05	0.11	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U238	B6.12117A	WATER	0.13	0.09	0.07	,,,,,,EM,,,,EN,EE,ER,EM,,EZ	--	PCI/L
0428-WSW05										
	NAREL GAM-01	Bi212	B6.12118B	WATER	-0.27	58	12.4	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Bi214	B6.12118B	WATER	0.03	1.2	1.84	,,U,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Cs137	B6.12118B	WATER	0.13	0.53	0.9	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12118B	WATER	6.94	7.35	9.98	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12118B	WATER	-0.58	13.7	21.6	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12118B	WATER	1.26	1.1	1.79	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb214	B6.12118B	WATER	-0.52	2.53	2.33	,,U,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Ra226	B6.12118B	WATER	8.2	13.1	21.6	,,UJ,,,,EM,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra228	B6.12118B	WATER	2.51	1.98	3.18	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Th234	B6.12118B	WATER	11.9	14	23	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12118B	WATER	0.02	0.58	1.01	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GR-01	Alpha	B6.12118B	WATER	6.1	20.5	16	,,UJ,,,,EM,,,,EN,EE,,EM,EC,EZ	UJ	PCI/L
	NAREL GR-01	Beta	B6.12118B	WATER	8.36	11.2	16.5	,,UJ,,,,EM,,,,EN,EE,,EM,EC,EZ	UJ	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12118B	WATER	0.56	0.2	0.12	,,,P1,,,,EM,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL TH-EICHROM	Th227	B6.12118B	WATER	0.02	0.08	0.16	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12118B	WATER	0.16	0.12	0.13	,,,,,,EM,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL TH-EICHROM	Th230	B6.12118B	WATER	0.07	0.15	0.27	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12118B	WATER	0.01	0.04	0.09	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L

Client ID	Method	Analyte	NARELID	Matrix	Conc	2S	MDA	Intermediate Qualifier Summary	Final Qualifier	Units
	NAREL U-EICHROM	U234	B6.12118B	WATER	1.88	0.37	0.1	,,,,,,EM,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U235	B6.12118B	WATER	0.1	0.09	0.1	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U238	B6.12118B	WATER	1.32	0.3	0.09	,,,,,,EM,,,,EN,EE,ER,EM,,EZ	--	PCI/L
0428-WSW06										
	NAREL GAM-01	Bi212	B6.12119C	WATER	-0.35	13.9	12.5	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Bi214	B6.12119C	WATER	-0.24	1.32	1.71	,,U,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Cs137	B6.12119C	WATER	-0.44	0.61	1	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12119C	WATER	4.15	8.73	11	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12119C	WATER	-0.35	13.3	21.6	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12119C	WATER	0.8	1.08	1.77	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb214	B6.12119C	WATER	-0.44	2.3	2.36	,,U,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Ra226	B6.12119C	WATER	11.5	13	21.2	,,UJ,,,,EM,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra228	B6.12119C	WATER	2.85	2.05	3.26	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Th234	B6.12119C	WATER	4.89	15.5	25.7	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12119C	WATER	-0.26	1.54	0.98	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GR-01	Alpha	B6.12119C	WATER	1.81	7.61	5.89	,,UJ,,,,EM,,,,EN,EE,,EM,EC,EZ	UJ	PCI/L
	NAREL GR-01	Beta	B6.12119C	WATER	12.2	6.29	8.65	,,,,,,EM,,,,EN,EE,,EM,,EZ	--	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12119C	WATER	0.31	0.15	0.1	,,,P1,,,,EM,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL TH-EICHROM	Th227	B6.12119C	WATER	-0.01	0.06	0.15	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12119C	WATER	0.12	0.1	0.14	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th230	B6.12119C	WATER	0.09	0.16	0.27	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12119C	WATER	0	0.03	0.07	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U234	B6.12119C	WATER	0.37	0.15	0.08	,,,,,,EM,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U235	B6.12119C	WATER	0.03	0.06	0.08	,,U,,,,EM,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U238	B6.12119C	WATER	0.24	0.12	0.07	,,,,,,EM,,,,EN,EE,ER,EM,,EZ	--	PCI/L
0428-WSW07										
	NAREL GAM-01	Bi212	B6.12120V	WATER	-0.35	3980	12.1	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Bi212	B6.12120V	WATER	0.78	7.04	11.9	,,U,,,,EM,,,,EN,EE,ER,EM,,	U	PCI/L

Client ID	Method	Analyte	NARELID	Matrix	Conc	2S	MDA	Intermediate Qualifier Summary	Final Qualifier	Units
	NAREL GAM-01	Bi214	B6.12120V	WATER	0.4	1.26	1.86	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Bi214	B6.12120V	WATER	-0.17	1.31	1.76	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Cs137	B6.12120V	WATER	0.02	0.57	0.96	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Cs137	B6.12120V	WATER	-0.2	0.56	0.94	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12120V	WATER	7.19	7.97	10.2	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	K40	B6.12120V	WATER	5.7	7.63	10.3	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12120V	WATER	-2.74	18.9	22.2	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb210	B6.12120V	WATER	1.37	12.7	21.6	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12120V	WATER	1.06	1.09	1.79	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Pb212	B6.12120V	WATER	1.78	1	1.42	,,,,,,EM,,,,,EN,EE,ER,EM,,	--	PCI/L
	NAREL GAM-01	Pb214	B6.12120V	WATER	-0.64	2.92	2.3	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Pb214	B6.12120V	WATER	-0.4	2.11	2.27	,,U,,,,,EM,,,J,,EN,EE,ER,EM,,	UJ	PCI/L
	NAREL GAM-01	Ra226	B6.12120V	WATER	8.81	12.6	20.8	,,UJ,,,,,EM,,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra226	B6.12120V	WATER	12.3	12.8	20.8	,,UJ,,,,,EM,,,,,EN,EE,R,EM,EC,	R	PCI/L
	NAREL GAM-01	Ra228	B6.12120V	WATER	1.95	1.87	3.02	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Ra228	B6.12120V	WATER	0.86	1.85	3.08	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Th234	B6.12120V	WATER	0.36	15	25	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Th234	B6.12120V	WATER	2.92	13.9	23.1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12120V	WATER	0	0.58	1.01	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GAM-01	Tl208	B6.12120V	WATER	-0.06	0.7	1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,	U	PCI/L
	NAREL GR-01	Alpha	B6.12120V	WATER	-0.78	7.89	6.9	,,UJ,,,,,EM,,,,,EN,EE,,EM,EC,EZ	UJ	PCI/L
	NAREL GR-01	Beta	B6.12120V	WATER	4.91	5.27	7.57	,,UJ,,,,,EM,,,,,EN,EE,,EM,EC,EZ	UJ	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12120V	WATER	0.38	0.18	0.14	,,,P1,,,,,EM,,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL RA226-EICHROM	Ra226	B6.12120V	WATER	0.51	0.2	0.12	,,,P1,,,,,EM,,,,,EN,EE,,EM,,EZ	J	PCI/L
	NAREL TH-EICHROM	Th227	B6.12120V	WATER	0	0.05	0.13	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th227	B6.12120V	WATER	0	0.08	0.19	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12120V	WATER	0	0.07	0.15	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th228	B6.12120V	WATER	0.07	0.08	0.11	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L

Client ID	Method	Analyte	NARELID	Matrix	Conc	2S	MDA	Intermediate Qualifier Summary	Final Qualifier	Units
	NAREL TH-EICHROM	Th230	B6.12120V	WATER	0.05	0.15	0.27	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th230	B6.12120V	WATER	0.09	0.15	0.27	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12120V	WATER	0	0.05	0.11	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL TH-EICHROM	Th232	B6.12120V	WATER	0.04	0.06	0.07	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U234	B6.12120V	WATER	0.43	0.16	0.09	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U234	B6.12120V	WATER	0.26	0.16	0.2	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U235	B6.12120V	WATER	0.06	0.08	0.1	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U235	B6.12120V	WATER	0.01	0.09	0.19	,,U,,,,,EM,,,,,EN,EE,ER,EM,,EZ	U	PCI/L
	NAREL U-EICHROM	U238	B6.12120V	WATER	0.22	0.13	0.15	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L
	NAREL U-EICHROM	U238	B6.12120V	WATER	0.2	0.12	0.1	,,,,,,EM,,,,,EN,EE,ER,EM,,EZ	--	PCI/L

Qualifier Explanation: See section 3 of the Memo DCN: W0428.4B.01257, Revision 2

Conc: Concentration

2 S: Two times the total propagated uncertainty

MDC: Minimum detectable concentration

Radiological Data Verification/Validation Checklist

Site Name: Canadian Radium Site, Mount Kisco, Westchester County, NY **Analytical Laboratory** NAREL
Case Number _____ * _____ **Reviewer** _____ Rick Haaker, CHP, CIH **Date** _____ March 17, 2017
RF Haaker

Part 1 - Sample Handling and Analysis Evaluation

MARLAP Ref.	Criteria	Yes	No	NA	Comments
8.5.1.1	Sample Descriptors - Each sample has a unique ID code which is cross-reference to unique Lab ID	X			
8.5.1.2	Aliquant Size - amount of sample used in analysis provided	X			
8.5.1.3	Dates of sample collection, sample prep and sample analysis provided	X			Sample sealed (prep) dates for NAREL GAM-01 samples were not provided. Contributes to uncertainty about Pb-214 and Bi-214.
8.5.1.4	Samples properly preserved	X			Evidence of acidification on Chain of Custody
8.5.1.5	Each analytical result linked to instrument/detector	X			
8.5.1.6	Traceability of standards and reference materials provided		X		This information was not provided in the package.
8.5.1.7	QC samples analyzed	X			
8.5.1.8	Yield (chemical separation, carrier and/or radiotracer) within acceptable ranges	X			
8.5.1.9	Self-absorption curve provided		X		Not provided.
8.5.1.10	Efficiency, calibration curves and instrument background information provided		X		This information was not provided in the package. Units of measure for background not the same as for samples
8.5.1.11	Spectrometry resolution data provided		X		This information was not provided in the package.
8.5.1.12	Dilution factors and corrections factors addressed and documentation provided.		X		This information was not provided in the package.
8.5.1.13	Count Time for each sample, QC analysis and instrument background provided	X			
8.5.1.14	For each measurement: 1) Measurement uncertainty reported 2) Analyte MDC reported 3) Appropriate units used	X X X			Except, backgrounds or method blanks were reported in activity units, not concentration units.

Part 2 - Quality Control

MARLAP Ref.	Criteria	Yes	No	NA	Comments
8.5.2.1	Method Blanks analyzed and no detected concentration/activity found		X		Activity was reported in the radium-226 background by method NAREL RA226-EICHROM, blank or background results were in incompatible units..
8.5.2.2	Laboratory Control Samples analyzed and within acceptable ranges	X			
8.5.2.3	Laboratory replicates analyzed and within control limits	X			Except where noted in report section 6.3. One of Bi-212 replicates had very suspicious uncertainty reported.
8.5.2.4	Matrix Spikes/Matrix Spike Duplicate analyzed and within established criteria	X			MSD not required by QAPP for water samples. MS performance was acceptable.
8.5.3.1	Test of detection information (critical value) provided.		X		The critical value was not required by QAPP.
8.5.3.2	Detection Capability: Required Minimum Detectable Concentration (RMDC) less than the Minimum Detectable Concentration (MDC) for each analyte	X			Except where noted. Several analytes reported by gamma spectroscopy had no RMDC listed in the QAPP
8.5.3.3	Uncertainty 1. Laboratory's combined standard uncertainty at concentrations lower than the action level less than required method uncertainty (expressed in concentration units) 2. Laboratory's relative combined standard uncertainty at concentrations above the action level less than required relative method uncertainty (express as a percent)			X X	No precision criteria was specified in the QAPP for individual analytical results.

Additional Comments: Gamma spectroscopy results for Ra-226 were rejected due to probable bias. NAREL does not produce CLP Level 4 equivalent packages, consequently a great many preliminary data qualifiers were assigned.

NAREL Sample Delivery Group: 1600054
Chain of Custody number: 2-120616-155527-0001

**DATA VALIDATION REPORT:
JUNE 2017 SAMPLING EVENT**



LABORATORY DATA CONSULTANTS, INC.

2701 Loker Ave. West, Suite 220, Carlsbad, CA 92010 Bus: 760-827-1100 Fax: 760-827-1099

Weston Solutions, Inc.
43 North Main Street
Concord, NH 03301
ATTN: Mr. Gerry Gilliland

September 8, 2017

SUBJECT: Phase 2 Water-Supply Well Sampling, Data Validation

Dear Mr. Gilliland,

Enclosed are the final validation reports for the fractions listed below. This SDG was received on August 24, 2017. Attachment 1 is a summary of the samples that were reviewed for each analysis.

LDC Project #39328:

<u>SDG #</u>	<u>Fraction</u>
30222947	Potassium, Gross Alpha & Beta, Radium-226, Radium-228, Radon, Total Uranium, Isotopic Uranium

The data validation was performed under Level IV guidelines. The analyses were validated using the following documents, as applicable to each method:

- Uniform Federal Policy - Quality Assurance Project Plan for Water Supply Well Sampling - Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York, June 2017
- Multi Agency Radiological Laboratory Analytical Protocols Manual, MARLAP, July 2004
- USEPA National Functional Guidelines for Inorganic Superfund Methods Data Review, January 2017

Please feel free to contact us if you have any questions.

Sincerely,

Pei Geng
Project Manager/Senior Chemist

Shaded cells indicate Level IV validation (all other cells are Level III validation). These sample counts do not include MS/MSD, and DUPs V:\LOGIN\Weston Solutions\Phase 2 Water Supply\39328ST.wpd

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Phase 2 Water-Supply Well Sampling

LDC Report Date: September 7, 2017

Parameters: Potassium

Validation Level: Level IV

Laboratory: Pace Analytical Services, LLC

Sample Delivery Group (SDG): 30222947

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
0428-WSW01-2	30222947001	Water	06/27/17
0428-WSW02-2	30222947002	Water	06/27/17
0428-WSW03-2	30222947003	Water	06/28/17
0428-WSW04-2	30222947004	Water	06/28/17
0428-WSW05-2	30222947005	Water	06/27/17
0428-WSW06-2	30222947006	Water	06/27/17
0428-WSW07-2	30222947007	Water	06/27/17
0428-WSW07-2MS	30222947007MS	Water	06/27/17
0428-WSW07-2MSD	30222947007MSD	Water	06/27/17
0428-WSW07-2DUP	30222947007DUP	Water	06/27/17

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Uniform Federal Policy – Quality Assurance Project Plan for Water Supply Well Sampling – Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York (June 2017) and a modified outline of the USEPA National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review (January 2017). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Potassium by Environmental Protection Agency (EPA) Method 200.7

All sample results were subjected to Level IV evaluation, which is comprised of the quality control (QC) summary forms as well as the raw data, to confirm sample quantitation and identification.

The following are definitions of the data qualifiers utilized during data validation:

- J+ (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.
- J- (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.
- J (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to non-conformances discovered during data validation. Bias is indeterminate.
- U (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however the compound or analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- N (Presumptive): The analysis indicates the presence of a compound or analyte that has been "tentatively identified."
- NJ (Presumptive and estimated): The analysis indicates the presence of a compound or analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- R (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.
- NA (Not Applicable): The non-conformance discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant the qualification of the data.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Instrument Calibration

Initial and continuing calibrations were performed as required by the method.

The initial calibration verification (ICV) and continuing calibration verification (CCV) standards were within QC limits.

III. ICP Interference Check Sample Analysis

The frequency of interference check sample (ICS) analysis was met. All criteria were within QC limits.

IV. Laboratory Blanks

Laboratory blanks were analyzed as required by the method. No contaminants were found in the laboratory blanks with the following exceptions:

Blank ID	Analyte	Maximum Concentration	Associated Samples
ICB/CCB	Potassium	28.5 ug/L	All samples in SDG 30222947

Data qualification by the laboratory blanks was based on the maximum contaminant concentration in the laboratory blanks in the analysis of each analyte. The sample concentrations were either not detected or were significantly greater than the concentrations found in the associated laboratory blanks.

V. Field Blanks

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on an associated project sample. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

VII. Duplicate Sample Analysis

Duplicate (DUP) sample analysis was performed on an associated project sample. Results were within QC limits.

VIII. Serial Dilution

Serial dilution was not performed for this SDG.

IX. Laboratory Control Samples

Laboratory control samples (LCS) were analyzed as required by the method. Percent recoveries (%R) were within QC limits.

X. Field Duplicates

Samples 0428-WSW02-2 and 0428-WSW06-2 were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

Analyte	Concentration (ug/L)		RPD (Limits)	Flag	A or P
	0428-WSW02-2	0428-WSW06-2			
Potassium	4650	4640	0 (≤ 20)	-	-

XI. Sample Result Verification

All sample result verifications were acceptable.

XII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

The quality control criteria reviewed were met and are considered acceptable. Based upon the data validation all results are considered valid and usable for all purposes.

**Phase 2 Water-Supply Well Sampling
Potassium - Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Potassium - Laboratory Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Potassium - Field Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

LDC #: 39328A4b

VALIDATION COMPLETENESS WORKSHEET

Date: 9-5-17

SDG #: 30222947

Level IV

Page: 1 of 1

Laboratory: Pace Analytical Services, LLC

Reviewer: MG

2nd Reviewer: C

METHOD: Potassium (EPA Method 200.7)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	Instrument Calibration	A	
III.	ICP Interference Check Sample (ICS) Analysis	A	
IV.	Laboratory Blanks	SW	
V.	Field Blanks	N	
VI.	Matrix Spike/Matrix Spike Duplicates	A	MS/MSD
VII.	Duplicate sample analysis	A	DUP
VIII.	Serial Dilution	N	not performed
IX.	Laboratory control samples	A	LCS
X.	Field Duplicates	SW	D= 2+6
XI.	Sample Result Verification	A	
XII.	Overall Assessment of Data	A	

Note: A = Acceptable
N = Not provided/applicable
SW = See worksheet

ND = No compounds detected
R = Rinsate
FB = Field blank

D = Duplicate
TB = Trip blank
EB = Equipment blank

SB=Source blank
OTHER:

	Client ID	Lab ID	Matrix	Date
1	0428-WSW01-2	30222947001	Water	06/27/17
2	0428-WSW02-2	30222947002	Water	06/27/17
3	0428-WSW03-2	30222947003	Water	06/28/17
4	0428-WSW04-2	30222947004	Water	06/28/17
5	0428-WSW05-2	30222947005	Water	06/27/17
6	0428-WSW06-2	30222947006	Water	06/27/17
7	0428-WSW07-2	30222947007	Water	06/27/17
8	0428-WSW07-2MS	30222947007MS	Water	06/27/17
9	0428-WSW07-2MSD	30222947007MSD	Water	06/27/17
10	0428-WSW07-2DUP	30222947007DUP	Water	06/27/17
11				
12				
13				
14				
15	PBW			

Notes:

Method: Metals (EPA SW 846 Method 6010/7000/6020)

Validation Area	Yes	No	NA	Findings/Comments
I. Technical holding times				
All technical holding times were met.	✓			
Cooler temperature criteria was met.	✓			
II. ICP/MS Tune				
Were all isotopes in the tuning solution mass resolution within 0.1 amu?			✓	
Were %RSD of isotopes in the tuning solution ≤ 5%?			✓	
III. Calibration				
Were all instruments calibrated daily, each set-up time?	✓			
Were the proper number of standards used?	✓			
Were all initial and continuing calibration verification %Rs within the 90-110% (80-120% for mercury) QC limits?	✓			
Were all initial calibration correlation coefficients > 0.995?	✓			
IV. Blanks				
Was a method blank associated with every sample in this SDG?	✓			
Was there contamination in the method blanks? If yes, please see the Blanks validation completeness worksheet.	✓			
V. ICP Interference Check Sample				
Were ICP interference check samples performed daily?	✓			
Were the AB solution percent recoveries (%R) with the 80-120% QC limits?			✓	N not spiked / not required
VI. Matrix spike/Matrix spike duplicates				
Were a matrix spike (MS) and duplicate (DUP) analyzed for each matrix in this SDG? If no, indicate which matrix does not have an associated MS/MSD or MS/DUP. Soil / Water.	✓			
Were the MS/MSD percent recoveries (%R) and the relative percent differences (RPD) within the 75-125 QC limits? If the sample concentration exceeded the spike concentration by a factor of 4 or more, no action was taken.	✓			
Were the MS/MSD or duplicate relative percent differences (RPD) ≤ 20% for waters and ≤ 35% for soil samples? A control limit of +/- RL (+/- 2X RL for soil) was used for samples that were ≤ 5X the RL, including when only one of the duplicate sample values were < 5X the RL.	✓			
VII. Laboratory control samples				
Was an LCS analyzed for this SDG?	✓			
Was an LCS analyzed per extraction batch?	✓			
Were the LCS percent recoveries (%R) and relative percent difference (RPD) within the 80-120% QC limits for water samples and laboratory established QC limits for soils?	✓			

LDC #: 39328A46

VALIDATION FINDINGS CHECKLIST

Page: 2 of 2
Reviewer: MG
2nd Reviewer: [Signature]

Validation Area	Yes	No	NA	Findings/Comments
VIII. Internal Standards (EPA SW 846 Method 6020/EPA 200.8)				
Were all the percent recoveries (%R) within the 30-120% (6020)/60-125% (200.8) of the intensity of the internal standard in the associated initial calibration?			✓	
If the %Rs were outside the criteria, was a reanalysis performed?			✓	
IX. ICP Serial Dilution				
Was an ICP serial dilution analyzed if analyte concentrations were > 50X the MDL (ICP)/>100X the MDL(ICP/MS)?		✓		
Were all percent differences (%Ds) < 10%?			✓	
Was there evidence of negative interference? If yes, professional judgement will be used to qualify the data.			✓	
X. Sample Result Verification				
Were RLs adjusted to reflect all sample dilutions and dry weight factors applicable to level IV validation?	✓			
XI. Overall assessment of data				
Overall assessment of data was found to be acceptable.	✓			
XII. Field duplicates				
Field duplicate pairs were identified in this SDG.	✓			
Target analytes were detected in the field duplicates.	✓			
XIII. Field blanks				
Field blanks were identified in this SDG.		✓		
Target analytes were detected in the field blanks.			✓	

LDC #: 39328A4b
SDG #: See Cover

METHOD: Trace metals (EPA SW 864 Method 200.7)

Sample Concentration units, unless otherwise noted: ug/L

VALIDATION FINDINGS WORKSHEET
PB/ICB/CCB QUALIFIED SAMPLES

Soil preparation factor applied: NA

Associated Samples: all (>RL)

Page: 1 of 1
Reviewer: MG
2nd Reviewer: Q

Analyte	Maximum PB ^a (mg/Kg)	Maximum PB ^a (ug/L)	Maximum ICB/CCB ^a (ug/L)	Action Limit	No Qual's.									
K			28.5											

Samples with analyte concentrations within five times the associated ICB, CCB or PB concentration are listed above with the identifications from the Validation Completeness Worksheet. These sample results were qualified as not detected, "U".

Note : a - The listed analyte concentration is the highest ICB, CCB, or PB detected in the analysis of each element.

LDC#: 39328A4b**VALIDATION FINDINGS WORKSHEET**
Field DuplicatesPage: 1 of 1
Reviewer: MG
2nd Reviewer: X**METHOD:** Metals (EPA Method 200.7)☒ Y ☐ N NA
☒ Y ☐ N NA

Were field duplicate pairs identified in this SDG?

Were target analytes detected in the field duplicate pairs?

Analyte	Concentration (ug/L)		RPD (≤ 20)	Qual. (Parent Only)
	2	6		
Potassium	4650	4640	0	

V:\FIELD DUPLICATES\Field Duplicates\FD_inorganic\2017\39328A4b.WPD

LDC #: 39328A46

VALIDATION FINDINGS WORKSHEET
Initial and Continuing Calibration Calculation Verification

Page: 1 of 1
Reviewer: MG
2nd Reviewer: 2

METHOD: Trace Metals (EPA SW 846 Method 6010/6020/7000)

An initial and continuing calibration verification percent recovery (%R) was recalculated for each type of analysis using the following formula:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where, Found = concentration (in ug/L) of each analyte measured in the analysis of the ICV or CCV solution
True = concentration (in ug/L) of each analyte in the ICV or CCV source

Standard ID	Type of Analysis	Element	Found (ug/L)	True (ug/L)	Recalculated	Reported	Acceptable (Y/N)
					%R	%R	
	ICP (Initial calibration)						
<u>1514</u> <u>ICV</u>	ICP/MS (Initial calibration)	<u>K</u>	<u>19650</u>	<u>20000</u>	<u>98.2</u>	<u>98.2</u>	<u>Y</u>
	CVAA (Initial calibration)						↓
	ICP (Continuing calibration)						
<u>1522</u> <u>CCV</u>	ICP/MS (Continuing calibration)	<u>K</u>	<u>10080</u>	<u>10000</u>	<u>100.8</u>	<u>100.8</u>	
	CVAA (Continuing calibration)						
	GFAA (Initial calibration)						
	GFAA (Continuing calibration)						

Comments: Refer to Calibration Verification findings worksheet for list of qualifications and associated samples when reported results do not agree within 10.0% of the recalculated results.

LDC #: 39328 A46

VALIDATION FINDINGS WORKSHEET **Level IV Recalculation Worksheet**

Page: 1 of 1
 Reviewer: MG
 2nd Reviewer: CD

METHOD: Trace Metals (EPA SW 846 Method 6010/6020/7000)

Percent recoveries (%R) for an ICP interference check sample, a laboratory control sample and a matrix spike sample were recalculated using the following formula:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where, Found = Concentration of each analyte measured in the analysis of the sample. For the matrix spike calculation, Found = SSR (spiked sample result) - SR (sample result).
 True = Concentration of each analyte in the source.

A sample and duplicate relative percent difference (RPD) was recalculated using the following formula:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where, S = Original sample concentration
 D = Duplicate sample concentration

An ICP serial dilution percent difference (%D) was recalculated using the following formula:

$$\%D = \frac{|I-SDR|}{I} \times 100$$

Where, I = Initial Sample Result (mg/L)
 SDR = Serial Dilution Result (mg/L) (Instrument Reading x 5)

Sample ID	Type of Analysis	Element	Found / S / I (units)	True / D / SDR (units)	Recalculated	Reported	Acceptable (Y/N)
					%R / RPD / %D	%R / RPD / %D	
-	ICP interference check	-	-	-	-	-	-
1542 LCS	Laboratory control sample	K	5208 (µg/L)	5000 (µg/L)	104	104	Y
1553 8	Matrix spike	K	(SSR-SR) 5456 (µg/L)	5000 (µg/L)	109	109	↓
1545/1549 10	Duplicate	K	5884 (µg/L)	5971 (µg/L)	1	1	↓
-	ICP serial dilution	-	-	-	-	-	-

Comments: Refer to appropriate worksheet for list of qualifications and associated samples when reported results do not agree within 10.0% of the recalculated results.

LDC #: 39328A46**VALIDATION FINDINGS WORKSHEET**
Sample Calculation VerificationPage: 1 of 1
Reviewer: M/G
2nd reviewer: Y**METHOD:** Trace Metals (EPA SW 846 Method 6010/6020/7000)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

- ☒ Y ☐ N ☐ N/A Have results been reported and calculated correctly?
☒ Y ☐ N ☐ N/A Are results within the calibrated range of the instruments and within the linear range of the ICP?
☒ Y ☐ N ☐ N/A Are all detection limits below the CRDL?

Detected analyte results for #1, K were recalculated and verified using the following equation:Concentration = $\frac{(RD)(FV)(Dil)}{(In. Vol.)}$

Recalculation:

RD = Raw data concentration
FV = Final volume (ml)
In. Vol. = Initial volume (ml) or weight (G)
Dil = Dilution factor

$$\frac{(6208 \mu g/L)(0.050 L)}{0.050 L} = 6208 \mu g/L$$

#	Sample ID	Analyte	Reported Concentration ($\mu g/L$)	Calculated Concentration ($\mu g/L$)	Acceptable (Y/N)
1	1	K	6210	6210	Y
2	2		4650	4650	
3	3		3870	3870	
4	4		4010	4010	
5	5		12200	12200	
6	6		4640	4640	
7	7		5880	5880	

Note: _____

Laboratory Data Consultants, Inc. Data Validation Report

Project/Site Name: Phase 2 Water-Supply Well Sampling

LDC Report Date: September 7, 2017

Parameters: Gross Alpha & Beta

Validation Level: Level IV

Laboratory: Pace Analytical Services, LLC

Sample Delivery Group (SDG): 30222947

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
0428-WSW01-2	30222947001	Water	06/27/17
0428-WSW02-2	30222947002	Water	06/27/17
0428-WSW03-2	30222947003	Water	06/28/17
0428-WSW04-2	30222947004	Water	06/28/17
0428-WSW05-2	30222947005	Water	06/27/17
0428-WSW06-2	30222947006	Water	06/27/17
0428-WSW07-2	30222947007	Water	06/27/17
0428-WSW07-2MS	30222947007MS	Water	06/27/17
0428-WSW07-2MSD	30222947007MSD	Water	06/27/17

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Uniform Federal Policy – Quality Assurance Project Plan for Water Supply Well Sampling – Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York (June 2017), the Multi Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual (July 2004), and a modified outline of the USEPA National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review (January 2017). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Gross Alpha and Beta by Environmental Protection Agency (EPA) Method 900.0

All sample results were subjected to Level IV data validation, which is comprised of the quality control (QC) summary forms as well as the raw data, to confirm sample quantitation and identification.

The following are definitions of the data qualifiers utilized during data validation:

- J+ (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.
- J- (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.
- J (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to non-conformances discovered during data validation. Bias is indeterminate.
- U (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however the compound or analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- N (Presumptive): The analysis indicates the presence of a compound or analyte that has been "tentatively identified."
- NJ (Presumptive and estimated): The analysis indicates the presence of a compound or analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- R (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.
- NA (Not Applicable): The non-conformance discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant the qualification of the data.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Initial Calibration

All criteria for the initial calibration were met.

Counting and detector efficiency were determined for each detector and each radionuclide.

Self absorption curves were generated for each sample when applicable.

III. Continuing Calibration

Continuing calibration and background determination were performed at the required frequencies. Results were within laboratory control limits.

IV. Blanks

Laboratory blanks were analyzed as required by the method. Blank results contained less than the minimum detectable activity (MDA).

V. Field Blanks

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on an associated project sample. Percent recoveries (%R) were within QC limits with the following exceptions:

Spike ID (Associated Samples)	Isotope	MS (%R) (Limits)	MSD (%R) (Limits)	Flag	A or P
0428-WSW07-2MS/MSD (All samples in SDG 30222947)	Gross beta	123 (60-110)	128 (60-110)	J+ (all detects)	A

Relative percent differences (RPD) were within QC limits.

VII. Duplicate Sample Analysis

The laboratory has indicated that there were no duplicate (DUP) analyses specified for the samples in this SDG, and therefore duplicate analyses were not performed for this SDG.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) and laboratory control samples duplicates (LCSD) were analyzed as required by the method. Percent recoveries (%R) were within QC limits with the following exceptions:

LCS ID (Associated Samples)	Isotope	LCS %R (Limits)	LCSD %R (Limits)	Flag	A or P
LCS/LCSD (All samples in SDG 30222947)	Gross beta	111.35 (60-110)	123.45 (60-110)	J+ (all detects)	P

Relative percent differences (RPD) were within QC limits.

IX. Field Duplicates

Samples 0428-WSW02-2 and 0428-WSW06-2 were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

Isotope	Activity (pCi/L)		RPD (Limits)	Flag	A or P
	0428-WSW02-2	0428-WSW06-2			
Gross alpha	0.994	0.723	32 (≤50)	-	-
Gross beta	2.76	3.21	15 (≤50)	-	-

X. Minimum Detectable Concentration

All minimum detectable concentration (MDC) met reporting limits (RL) with the following exceptions:

Sample	Isotope	MDC	RL
0428-WSW05-2	Gross alpha	5.17 pCi/L	3 pCi/L

The MDC was greater than the RL as listed above.

XI. Sample Result Verification

All sample result verifications were acceptable.

XII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

Due to MS/MSD %R and LCS/LCSD %R, data were qualified as estimated in seven samples.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

**Phase 2 Water-Supply Well Sampling
Gross Alpha & Beta - Data Qualification Summary - SDG 30222947**

Sample	Isotope	Flag	A or P	Reason
0428-WSW01-2 0428-WSW02-2 0428-WSW03-2 0428-WSW04-2 0428-WSW05-2 0428-WSW06-2 0428-WSW07-2	Gross beta	J+ (all detects)	A	Matrix spike/Matrix spike duplicate (%R)
0428-WSW01-2 0428-WSW02-2 0428-WSW03-2 0428-WSW04-2 0428-WSW05-2 0428-WSW06-2 0428-WSW07-2	Gross beta	J+ (all detects)	P	Laboratory control samples (%R)

**Phase 2 Water-Supply Well Sampling
Gross Alpha & Beta - Laboratory Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Gross Alpha & Beta - Field Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

METHOD: Gross Alpha & Beta (EPA Method 900.0)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	Initial calibration	A	Self Absorption Curve ✓
III.	Calibration verification	A	
IV.	Laboratory Blanks	A	PB only
V.	Field blanks	N	
VI.	Matrix Spike/Matrix Spike Duplicates	SW	MS/MSD
VII.	Duplicates	N	client specified
VIII.	Laboratory control samples	SW	LCS/LCSD
IX.	Field duplicates	SW	D = 2 + 6
X.	Minimum detectable activity (MDA)	SW	
XI.	Sample result verification	A	
XII.	Overall assessment of data	A	

Note: A = Acceptable
N = Not provided/applicable
SW = See worksheet

ND = No compounds detected
R = Rinsate
FB = Field blank

D = Duplicate
TB = Trip blank
EB = Equipment blank

SB = Source blank
OTHER:

	Client ID	Lab ID	Matrix	Date
1	0428-WSW01-2	30222947001	Water	06/27/17
2	0428-WSW02-2	30222947002	Water	06/27/17
3	0428-WSW03-2	30222947003	Water	06/28/17
4	0428-WSW04-2	30222947004	Water	06/28/17
5	0428-WSW05-2	30222947005	Water	06/27/17
6	0428-WSW06-2	30222947006	Water	06/27/17
7	0428-WSW07-2	30222947007	Water	06/27/17
8	0428-WSW07-2MS	30222947007MS	Water	06/27/17
9	0428-WSW07-2MSD	30222947007MSD	Water	06/27/17
10				
11				
12				
13				
14	PBW			

Notes: _____

Method: Radiochemistry(EPA Method 900.0)

Validation Area	Yes	No	NA	Findings/Comments
I. Technical holding times				
All technical holding times were met.	✓			
II. Calibration				
Were all instruments and detectors calibration as required?	✓			
Were NIST traceable standards used for all calibrations?	✓			
Was the check source identified by activity and radionuclide?	✓			
Were check sources including background counts analyzed at the required frequency and within laboratory control limits?	✓			
III. Blanks				
Were blank analyses performed as required?	✓			
Were any activities detected in the blanks greater than the minimum detectable activity (MDA)? If yes, please see the Blanks validation completeness worksheet.		✓		
IV. Matrix spikes and Duplicates				
Were a matrix spike (MS) analyzed for each matrix in this SDG? If no, indicate which matrix does not have an associated MS/MSD or MS/DUP. Soil / Water.	✓			
Were the MS percent recoveries (%R) within the QC limits? If the sample concentration exceeded the spike concentration by a factor of 4 or more, no action was taken.		✓		
Was a duplicate sample analyzed at the required frequency of 5% in this SDG?		✓		
Were all duplicate sample duplicate error ratios (DER) <1.42?			✓	
V. Laboratory control samples				
Was an LCS analyzed per analytical batch?	✓			
Were the LCS percent recoveries (%R) and relative percent difference (RPD) within the 75-125%		✓		
VI. Sample Chemical/Carrier Recovery				
Was a tracer/carrier added to each sample?		✓		
Were tracer/carrier recoveries within the QC limits?			✓	
VII. Regional Quality Assurance and Quality Control				
Were performance evaluation (PE) samples performed?		✓		
Were the performance evaluation (PE) samples within the acceptance limits?			✓	
VIII. Sample Result Verification				
Were activities adjusted to reflect all sample dilutions and dry weight factors applicable to level IV validation?	✓			
Were the Minimum Detectable Activities (MDA) < RL?		✓		

LDC #: 39328A22

VALIDATION FINDINGS CHECKLIST

Page: 2 of 2
Reviewer: MG
2nd Reviewer: Y

Validation Area	Yes	No	NA	Findings/Comments
IX. Overall assessment of data				
Overall assessment of data was found to be acceptable.	✓			
X. Field duplicates				
Field duplicate pairs were identified in this SDG.	✓			
Target analytes were detected in the field duplicates.	✓			
XI. Field blanks				
Field blanks were identified in this SDG.		✓		
Target analytes were detected in the field blanks.			✓	

METHOD: Radiochemistry (Method: 900.0)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A Was a laboratory control sample (LCS) analyzed at the required frequency in this SDG?

Y(N) N/A Were all LCS and LCSD percent recoveries (%R) within the control limits of 75-125% and RPD <20%?

LEVEL IV ONLY:

(Y)N N/A Were recalculated results acceptable? See Level IV Recalculation Worksheet for recalculations.

[illegible]

Comments:

LDC# 39328A22**VALIDATION FINDINGS WORKSHEET**
Field DuplicatesPage: 1 of 1
Reviewer: MG
2nd Reviewer: XRadiochemistry, Method 900.0

Isotope	Activity (pCi/L)		RPD (≤50)	Qualification (Parent Only)
	2	6		
Gross Alpha	0.994	0.723	32	
Gross Beta	2.76	3.21	15	

V:\FIELD DUPLICATES\Field Duplicates\FD_inorganic\2017\39328A22.wpd

LDC #: 39328A22

VALIDATION FINDINGS WORKSHEET

Minimum Detectable Activities

Page: 1 of 1

Reviewer: MG

2nd Reviewer:

METHOD: Radiochemistry (Method: 900.0)

The following sample MDAs are above the RDL:

— (pci/L) —

[illegible]

Comments: MDC = Minimum Detectable Concentration

LDC #: 39328A22

VALIDATION FINDINGS WORKSHEET **Level IV Recalculation Worksheet**

Page: 1 of 1Reviewer: AG2nd Reviewer: AGMETHOD: Radiochemistry (Method: 900.0)

Percent recoveries (%R) for a laboratory control sample, a matrix spike and a matrix spike duplicate sample were recalculated using the following formula:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where, Found = activity of each analyte measured in the analysis of the sample.
 True = activity of each analyte in the source.

A matrix spike and matrix spike duplicate relative percent difference (RPD) was recalculated using the following formula:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where, S = Original sample activity
 D = Duplicate sample activity

Sample ID	Type of Analysis	Analyte	Found/S (units)	True/D (units)	Recalculated	Reported	Acceptable (Y/N)
					%R or RPD	%R or RPD	
LC S	Laboratory control sample	Gross Alpha	25.42 (pci/L)	30.86 (pci/L)	82.37	82.37	Y
8	Matrix spike sample	Gross Beta	48.88 (pci/L)	39.73 (pci/L)	123	123	↓
8/9	Duplicate RPD	Gross Alpha	61.33 (pci/L)	67.17 (pci/L)	9.09	* 7.63	
—	Chemical recovery	—	—	—	—	—	—

Comments: * RPD was based on MS/MSD % recoveries, not on activities.

LDC #: 39328A22

VALIDATION FINDINGS WORKSHEET Sample Calculation Verification

Page: 1 of 1
Reviewer: MG
2nd reviewer: V

METHOD: Radiochemistry (Method: 900.0)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A

Have results been reported and calculated correctly?

Y N N/A

Are results within the calibrated range of the instruments?

Analyte results for #1, Gross Alpha reported with a positive detect were recalculated and verified using the following equation:

Concentration =

Recalculation:

$$\frac{(\text{cpm} - \text{background})}{2.22 \times E \times SA \times \text{Vol}}$$

$$\frac{(0.1303 \text{ cpm}) - (0.0430 \text{ cpm}) - (0.000 \text{ cpm})}{(2.22)(0.1732)(0.11847 \text{ L})} = 1.916 \text{ pCi/L}$$

E = Counter Efficiency

SA = Self-absorbance factor

Vol = Volume of sample

#	Sample ID	Analyte	Reported Concentration (pCi/L)	Calculated Concentration (pCi/L)	Acceptable (Y/N)
1	1	Gross Alpha	1.92	1.92	Y
2	2	Gross Beta	2.76	2.75	
3	3	Gross Alpha	2.82	2.82	
4	4	Gross Beta	3.59	3.59	
5	5	Gross Alpha	8.82	8.80	
6	6	Gross Beta	3.21	3.21	
7	7	Gross Alpha	4.19	4.19	↓

Note: _____

Laboratory Data Consultants, Inc. Data Validation Report

Project/Site Name: Phase 2 Water-Supply Well Sampling

LDC Report Date: September 7, 2017

Parameters: Radium-226

Validation Level: Level IV

Laboratory: Pace Analytical Services, LLC

Sample Delivery Group (SDG): 30222947

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
0428-WSW01-2	30222947001	Water	06/27/17
0428-WSW02-2	30222947002	Water	06/27/17
0428-WSW03-2	30222947003	Water	06/28/17
0428-WSW04-2	30222947004	Water	06/28/17
0428-WSW05-2	30222947005	Water	06/27/17
0428-WSW06-2	30222947006	Water	06/27/17
0428-WSW07-2	30222947007	Water	06/27/17
0428-WSW07-2MS	30222947007MS	Water	06/27/17
0428-WSW07-2MSD	30222947007MSD	Water	06/27/17

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Uniform Federal Policy – Quality Assurance Project Plan for Water Supply Well Sampling – Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York (June 2017), the Multi Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual (July 2004), and a modified outline of the USEPA National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review (January 2017). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Radium-226 by Environmental Protection Agency (EPA) Method 903.1

All sample results were subjected to Level IV data validation, which is comprised of the quality control (QC) summary forms as well as the raw data, to confirm sample quantitation and identification.

The following are definitions of the data qualifiers utilized during data validation:

- J+ (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.
- J- (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.
- J (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to non-conformances discovered during data validation. Bias is indeterminate.
- U (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however the compound or analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- N (Presumptive): The analysis indicates the presence of a compound or analyte that has been "tentatively identified."
- NJ (Presumptive and estimated): The analysis indicates the presence of a compound or analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- R (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.
- NA (Not Applicable): The non-conformance discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant the qualification of the data.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Initial Calibration

All criteria for the initial calibration were met.

Counting and detector efficiency were determined for each detector and each radionuclide.

III. Continuing Calibration

Continuing calibration and background determination were performed at the required frequencies. Results were within laboratory control limits.

IV. Blanks

Laboratory blanks were analyzed as required by the method. Blank results contained less than the minimum detectable activity (MDA) with the following exceptions:

Blank ID	Isotope	Activity	Associated Samples
PB (prep blank)	Radium-226	0.272 pCi/L	All samples in SDG 30222947

Sample activities were compared to activities detected in the laboratory blanks. The sample activities were either not detected or were significantly greater than the activities found in the associated laboratory blanks with the following exceptions:

Sample	Isotope	Reported Activity	Modified Final Activity
0428-WSW02-2	Radium-226	0.271 pCi/L	0.3U pCi/L

V. Field Blanks

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on an associated project sample. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

VII. Duplicate Sample Analysis

The laboratory has indicated that there were no duplicate (DUP) analyses specified for the samples in this SDG, and therefore duplicate analyses were not performed for this SDG.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) were analyzed as required by the method. Percent recoveries (%R) were within QC limits.

IX. Field Duplicates

Samples 0428-WSW02-2 and 0428-WSW06-2 were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

Isotope	Activity (pCi/L)		RPD (Limits)	Flag	A or P
	0428-WSW02-2	0428-WSW06-2			
Radium-226	0.271	0.815	100 (≤ 50)	J (all detects)	A

X. Tracer Recovery

All tracer recoveries were within validation criteria.

XI. Minimum Detectable Concentration

All minimum detectable concentration (MDC) met reporting limits (RL).

XII. Sample Result Verification

All sample result verifications were acceptable.

XIII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

Due to field duplicate RPD, data were qualified as estimated in two samples.

Due to laboratory blank contamination, data were qualified as not detected in one sample.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

**Phase 2 Water-Supply Well Sampling
Radium-226 - Data Qualification Summary - SDG 30222947**

Sample	Isotope	Flag	A or P	Reason
0428-WSW02-2 0428-WSW06-2	Radium-226	J (all detects)	A	Field duplicates (RPD)

**Phase 2 Water-Supply Well Sampling
Radium-226 - Laboratory Blank Data Qualification Summary - SDG 30222947**

Sample	Isotope	Modified Final Activity	A or P
0428-WSW02-2	Radium-226	0.3U pCi/L	A

**Phase 2 Water-Supply Well Sampling
Radium-226 - Field Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

METHOD: Radium 226 (EPA Method 903.1)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	Initial calibration	A	
III.	Calibration verification	A	
IV.	Laboratory Blanks	SW	PB only
V.	Field blanks	N	
VI.	Matrix Spike/Matrix Spike Duplicates	A	MS/MSD
VII.	Duplicates	N	client specified
VIII.	Laboratory control samples	A	LCS
IX.	Field duplicates	SW	D=2+6
X.	Tracer Carrier recovery	A	
XI.	Minimum detectable activity (MDA)	A	
XII.	Sample result verification	A	
XIII.	Overall assessment of data	A	

Note: A = Acceptable ND = No compounds detected D = Duplicate SB=Source blank
N = Not provided/applicable R = Rinsate TB = Trip blank OTHER:
SW = See worksheet FB = Field blank EB = Equipment blank

	Client ID	Lab ID	Matrix	Date
1	0428-WSW01-2	30222947001	Water	06/27/17
2	0428-WSW02-2	30222947002	Water	06/27/17
3	0428-WSW03-2	30222947003	Water	06/28/17
4	0428-WSW04-2	30222947004	Water	06/28/17
5	0428-WSW05-2	30222947005	Water	06/27/17
6	0428-WSW06-2	30222947006	Water	06/27/17
7	0428-WSW07-2	30222947007	Water	06/27/17
8	0428-WSW07-2MS	30222947007MS	Water	06/27/17
9	0428-WSW07-2MSD	30222947007MSD	Water	06/27/17
10				
11				
12				
13				
14				
15	PBW			

Notes: _____

Method:Radiochemistry(EPA Method 903.1)

Validation Area	Yes	No	NA	Findings/Comments
I. Technical holding times				
All technical holding times were met.	✓			
II. Calibration				
Were all instruments and detectors calibration as required?	✓			
Were NIST traceable standards used for all calibrations?	✓			
Was the check source identified by activity and radionuclide?	✓			
Were check sources including background counts analyzed at the required frequency and within laboratory control limits?	✓			
III. Blanks				
Were blank analyses performed as required?	✓			
Were any activities detected in the blanks greater than the minimum detectable activity (MDA)? If yes, please see the Blanks validation completeness worksheet.	✓			
IV. Matrix spikes and Duplicates				
Were a matrix spike (MS) analyzed for each matrix in this SDG? If no, indicate which matrix does not have an associated MS/MSD or MS/DUP. Soil / Water.	✓			
Were the MS percent recoveries (%R) within the QC limits? If the sample concentration exceeded the spike concentration by a factor of 4 or more, no action was taken.	✓			
Was a duplicate sample analyzed at the required frequency of 5% in this SDG?		✓		
Were all duplicate sample duplicate error ratios (DER) <1.42?			✓	
V. Laboratory control samples				
Was an LCS analyzed per analytical batch?	✓			
Were the LCS percent recoveries (%R) and relative percent difference (RPD) within the 75-125%	✓			
VI. Sample Chemical/Carrier Recovery				
Was a tracer/carrier added to each sample?	✓			
Were tracer/carrier recoveries within the QC limits?	✓			
VII. Regional Quality Assurance and Quality Control				
Were performance evaluation (PE) samples performed?		✓		
Were the performance evaluation (PE) samples within the acceptance limits?			✓	
VIII. Sample Result Verification				
Were activities adjusted to reflect all sample dilutions and dry weight factors applicable to level IV validation?	✓			
Were the Minimum Detectable Activities (MDA) < RL?	✓			

LDC #: 39328A29a

VALIDATION FINDINGS CHECKLIST

Page: 2 of 2
Reviewer: MG
2nd Reviewer: Q

Validation Area	Yes	No	NA	Findings/Comments
IX. Overall assessment of data				
Overall assessment of data was found to be acceptable.	✓			
X. Field duplicates				
Field duplicate pairs were identified in this SDG.	✓			
Target analytes were detected in the field duplicates.	✓			
XI. Field blanks				
Field blanks were identified in this SDG.		✓		
Target analytes were detected in the field blanks.			✓	

VALIDATION FINDINGS WORKSHEET
Blanks**METHOD:** Radiochemistry, Method 903.1

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

☒ **N** N/A Were blank analyses performed as required? If no, please see qualifications below.☒ **N** N/A Were any activities in the blanks greater than the minimum detectable activity? If yes, please see qualifications below.**Conc. units:** pCi/L**Associated Samples:** all

Isotope	Blank ID	Blank Action Limit	Sample Identification										
	PB		2										
Ra-226	0.272		0.271/0.3U										

CIRCLED RESULTS WERE NOT QUALIFIED. ALL RESULTS NOT CIRCLED WERE QUALIFIED BY THE FOLLOWING STATEMENT:

All contaminants within five times the method blank concentration were qualified as not detected, "U".

LDC# 39328A29a

VALIDATION FINDINGS WORKSHEET

Field Duplicates

Page: 1 of 1

Reviewer: MG

2nd Reviewer: S

Radiochemistry, Method 903.1

Isotope	Activity (pCi/L)		RPD (≤50)	Qualification (Parent Only)
	2	6		
Ra-226	0.271	0.815	100	J/UJ/A (all dets)

V:\FIELD DUPLICATES\Field Duplicates\FD_inorganic\2017\39328A29a.wpd

LDC #: 39328A29a

VALIDATION FINDINGS WORKSHEET **Level IV Recalculation Worksheet**

Page: 1 of 1Reviewer: MG2nd Reviewer: QMETHOD: Radiochemistry (Method: 903.1)

Percent recoveries (%R) for a laboratory control sample, a matrix spike and a matrix spike duplicate sample were recalculated using the following formula:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where, Found = activity of each analyte measured in the analysis of the sample.
 True = activity of each analyte in the source.

A matrix spike and matrix spike duplicate relative percent difference (RPD) was recalculated using the following formula:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where, S = Original sample activity
 D = Duplicate sample activity

Sample ID	Type of Analysis	Analyte	Found/S (units)	True/D (units)	Recalculated	Reported	Acceptable (Y/N)
					%R or RPD	%R or RPD	
LCS	Laboratory control sample	Ra-226	8.81 (pCi/L)	10.00 (pCi/L)	88.10	88.12	Y
8	Matrix spike sample	Ra-226	18.60 (pCi/L)	19.99 (pCi/L)	93.05	93.03	↓
8/9	Duplicate RPD	Ra-226	19.19 (pCi/L)	19.74 (pCi/L)	2.83	* 2.56	
1	Chemical recovery	Ba-133	1973 (cts)	2086 (cts)	95	95	

*

Comments: Lab used % recovery for RPD calculation, not sample activities

LDC #: 39328A29a**VALIDATION FINDINGS WORKSHEET**
Sample Calculation VerificationPage: 1 of 1Reviewer: M/G2nd reviewer: X**METHOD:** Radiochemistry (Method: 903.1)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A

Have results been reported and calculated correctly?

Y N N/A

Are results within the calibrated range of the instruments?

Analyte results for #1, Ra-226 reported with a positive detect were recalculated and verified using the following equation:

Concentration =

$$\frac{(\text{cpm} - \text{background})}{2.22 \times E \times SA \times \text{Vol}}$$

Recalculation:

$$\frac{(16 \text{ cts} / 10 \text{ min}) - (0 \text{ cts} / 10 \text{ min})}{(2.22)(2.4475)(0.80095 \text{ L})(0.9458)} \times \frac{1}{0.7910} \times \frac{1}{0.9769} \times \frac{1}{0.9994} = 0.5034 \frac{\text{pCi}}{\text{L}}$$

E = Counter Efficiency

SA = Self-absorbance factor

Vol = Volume of sample

#	Sample ID	Analyte	Reported Concentration (pCi/L)	Calculated Concentration (pCi/L)	Acceptable (Y/N)
1	1	Ra-226	0.503	0.503	Y
2	2		0.271	0.271	
3	3		0.519	0.519	
4	4		0.677	0.677	
5	5		0.364	0.364	
6	6		0.815	0.815	
7	7		0.594	0.594	

Note: _____

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Phase 2 Water-Supply Well Sampling

LDC Report Date: September 7, 2017

Parameters: Radium-228

Validation Level: Level IV

Laboratory: Pace Analytical Services, LLC

Sample Delivery Group (SDG): 30222947

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
0428-WSW01-2	30222947001	Water	06/27/17
0428-WSW02-2	30222947002	Water	06/27/17
0428-WSW03-2	30222947003	Water	06/28/17
0428-WSW04-2	30222947004	Water	06/28/17
0428-WSW05-2	30222947005	Water	06/27/17
0428-WSW06-2	30222947006	Water	06/27/17
0428-WSW07-2	30222947007	Water	06/27/17
0428-WSW07-2MS	30222947007MS	Water	06/27/17
0428-WSW07-2MSD	30222947007MSD	Water	06/27/17

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Uniform Federal Policy – Quality Assurance Project Plan for Water Supply Well Sampling – Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York (June 2017), the Multi Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual (July 2004), and a modified outline of the USEPA National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review (January 2017). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Radium-228 by Environmental Protection Agency (EPA) Method 904.0

All sample results were subjected to Level IV data validation, which is comprised of the quality control (QC) summary forms as well as the raw data, to confirm sample quantitation and identification.

The following are definitions of the data qualifiers utilized during data validation:

- J+ (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.
- J- (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.
- J (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to non-conformances discovered during data validation. Bias is indeterminate.
- U (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however the compound or analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- N (Presumptive): The analysis indicates the presence of a compound or analyte that has been "tentatively identified."
- NJ (Presumptive and estimated): The analysis indicates the presence of a compound or analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- R (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.
- NA (Not Applicable): The non-conformance discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant the qualification of the data.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Initial Calibration

All criteria for the initial calibration were met.

Counting and detector efficiency were determined for each detector and each radionuclide.

III. Continuing Calibration

Continuing calibration and background determination were performed at the required frequencies. Results were within laboratory control limits.

IV. Blanks

Laboratory blanks were analyzed as required by the method. Blank results contained less than the minimum detectable activity (MDA).

V. Field Blanks

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on an associated project sample. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

VII. Duplicate Sample Analysis

The laboratory has indicated that there were no duplicate (DUP) analyses specified for the samples in this SDG, and therefore duplicate analyses were not performed for this SDG.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) were analyzed as required by the method. Percent recoveries (%R) were within QC limits.

IX. Field Duplicates

Samples 0428-WSW02-2 and 0428-WSW06-2 were identified as field duplicates. No results were detected in any of the samples.

X. Tracer/Carrier Recovery

All tracer and carrier recoveries were within validation criteria.

XI. Minimum Detectable Concentration

All minimum detectable concentration (MDC) met reporting limits (RL).

XII. Sample Result Verification

All sample result verifications were acceptable.

XIII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

The quality control criteria reviewed were met and are considered acceptable. Based upon the data validation all results are considered valid and usable for all purposes.

**Phase 2 Water-Supply Well Sampling
Radium-228 - Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Radium-228 - Laboratory Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Radium-228 - Field Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

LDC #: 39328A29b **VALIDATION COMPLETENESS WORKSHEET**
 SDG #: 30222947 Level IV
 Laboratory: Pace Analytical Services, LLC

Date: 9-5-17
 Page: 1 of 1
 Reviewer: MG
 2nd Reviewer: [Signature]

METHOD: Radium 228 (EPA Method 904.0)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	Initial calibration	A	
III.	Calibration verification	A	
IV.	Laboratory Blanks	A	PB only
V.	Field blanks	N	
VI.	Matrix Spike/Matrix Spike Duplicates	A	MS/MSD
VII.	Duplicates	N	client specified
VIII.	Laboratory control samples	A	LCS
IX.	Field duplicates	ND	D = 2 + 6
X.	Carrier recovery <i>Ba tracer Y carrier</i>	A	
XI.	Minimum detectable activity (MDA)	A	
XII.	Sample result verification	A	
XIII.	Overall assessment of data	A	

Note: A = Acceptable
 N = Not provided/applicable
 SW = See worksheet

ND = No compounds detected
 R = Rinsate
 FB = Field blank

D = Duplicate
 TB = Trip blank
 EB = Equipment blank

SB = Source blank
 OTHER:

	Client ID	Lab ID	Matrix	Date
1	0428-WSW01-2	30222947001	Water	06/27/17
2	0428-WSW02-2	30222947002	Water	06/27/17
3	0428-WSW03-2	30222947003	Water	06/28/17
4	0428-WSW04-2	30222947004	Water	06/28/17
5	0428-WSW05-2	30222947005	Water	06/27/17
6	0428-WSW06-2	30222947006	Water	06/27/17
7	0428-WSW07-2	30222947007	Water	06/27/17
8	0428-WSW07-2MS	30222947007MS	Water	06/27/17
9	0428-WSW07-2MSD	30222947007MSD	Water	06/27/17
10				
11				
12				
13				
14				
15	PBW			

Notes: _____

Method: Radiochemistry(EPA Method 904.0)

Validation Area	Yes	No	NA	Findings/Comments
I. Technical holding times				
All technical holding times were met.	✓			
II. Calibration				
Were all instruments and detectors calibration as required?	✓			
Were NIST traceable standards used for all calibrations?	✓			
Was the check source identified by activity and radionuclide?	✓			
Were check sources including background counts analyzed at the required frequency and within laboratory control limits?	✓			
III. Blanks				
Were blank analyses performed as required?	✓			
Were any activities detected in the blanks greater than the minimum detectable activity (MDA)? If yes, please see the Blanks validation completeness worksheet.		✓		
IV. Matrix spikes and Duplicates				
Were a matrix spike (MS) analyzed for each matrix in this SDG? If no, indicate which matrix does not have an associated MS/MSD or MS/DUP. Soil / Water.	✓			
Were the MS percent recoveries (%R) within the QC limits? If the sample concentration exceeded the spike concentration by a factor of 4 or more, no action was taken.	✓			
Was a duplicate sample analyzed at the required frequency of 5% in this SDG?		✓		
Were all duplicate sample duplicate error ratios (DER) ≤1.42?			✓	
V. Laboratory control samples				
Was an LCS analyzed per analytical batch?	✓			
Were the LCS percent recoveries (%R) and relative percent difference (RPD) within the 75-125%	✓			
VI. Sample Chemical/Carrier Recovery				
Was a tracer/carrier added to each sample?	✓			
Were tracer/carrier recoveries within the QC limits?	✓			
VII. Regional Quality Assurance and Quality Control				
Were performance evaluation (PE) samples performed?		✓		
Were the performance evaluation (PE) samples within the acceptance limits?			✓	
VIII. Sample Result Verification				
Were activities adjusted to reflect all sample dilutions and dry weight factors applicable to level IV validation?	✓			
Were the Minimum Detectable Activities (MDA) < RL?	✓			

LDC #: 39328A296

VALIDATION FINDINGS CHECKLIST

Page: 2 of 2
Reviewer: MG
2nd Reviewer: Q

Validation Area	Yes	No	NA	Findings/Comments
IX. Overall assessment of data				
Overall assessment of data was found to be acceptable.	✓			
X. Field duplicates				
Field duplicate pairs were identified in this SDG.	✓			
Target analytes were detected in the field duplicates.		✓		
XI. Field blanks				
Field blanks were identified in this SDG.		✓		
Target analytes were detected in the field blanks.			✓	

LDC #: 39328A296

VALIDATION FINDINGS WORKSHEET **Level IV Recalculation Worksheet**

Page: 1 of 1Reviewer: MG2nd Reviewer: QMETHOD: Radiochemistry (Method: 904.0)

Percent recoveries (%R) for a laboratory control sample, a matrix spike and a matrix spike duplicate sample were recalculated using the following formula:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where, Found = activity of each analyte measured in the analysis of the sample.
 True = activity of each analyte in the source.

A matrix spike and matrix spike duplicate relative percent difference (RPD) was recalculated using the following formula:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where, S = Original sample activity
 D = Duplicate sample activity

Sample ID	Type of Analysis	Analyte	Found/S (units)	True/D (units)	Recalculated	Reported	Acceptable (Y/N)
					%R or RPD	%R or RPD	
LCS	Laboratory control sample	Ra-228	5.37 (pCi/L)	5.92 (pCi/L)	90.71	90.65	Y
8	Matrix spike sample	Ra-228	9.84 (pCi/L)	8.91 (pCi/L)	110.44	* 104.39	
8/9	Duplicate RPD	Ra-228	9.84 (pCi/L)	9.79 (pCi/L)	0.51	** 1.92	
1	Chemical recovery	Y	19.9 (mg)	25.48 (mg)	78	78	

* Lab subtracts out parent conc. < MDC before calculation

Comments: ** Lab uses % rec for RPD calculation, not sample activity

Laboratory Data Consultants, Inc. Data Validation Report

Project/Site Name: Phase 2 Water-Supply Well Sampling

LDC Report Date: September 7, 2017

Parameters: Total Uranium

Validation Level: Level IV

Laboratory: Pace Analytical Services, LLC

Sample Delivery Group (SDG): 30222947

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
0428-WSW01-2	30222947001	Water	06/27/17
0428-WSW02-2	30222947002	Water	06/27/17
0428-WSW03-2	30222947003	Water	06/28/17
0428-WSW04-2	30222947004	Water	06/28/17
0428-WSW05-2	30222947005	Water	06/27/17
0428-WSW06-2	30222947006	Water	06/27/17
0428-WSW07-2	30222947007	Water	06/27/17
0428-WSW07-2MS	30222947007MS	Water	06/27/17
0428-WSW07-2MSD	30222947007MSD	Water	06/27/17

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Uniform Federal Policy – Quality Assurance Project Plan for Water Supply Well Sampling – Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York (June 2017), the Multi Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual (July 2004), and a modified outline of the USEPA National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review (January 2017). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Total Uranium by American Society for Testing and Materials (ASTM) D5174-97

All sample results were subjected to Level IV data validation, which is comprised of the quality control (QC) summary forms as well as the raw data, to confirm sample quantitation and identification.

The following are definitions of the data qualifiers utilized during data validation:

- J+ (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.
- J- (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.
- J (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to non-conformances discovered during data validation. Bias is indeterminate.
- U (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however the compound or analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- N (Presumptive): The analysis indicates the presence of a compound or analyte that has been "tentatively identified."
- NJ (Presumptive and estimated): The analysis indicates the presence of a compound or analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- R (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.
- NA (Not Applicable): The non-conformance discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant the qualification of the data.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Initial Calibration

All criteria for the initial calibration were met.

Counting and detector efficiency were determined for each detector and each radionuclide.

III. Continuing Calibration

Continuing calibration and background determination were performed at the required frequencies. Results were within laboratory control limits.

IV. Blanks

Laboratory blanks were analyzed as required by the method. Blank results contained less than the minimum detectable activity (MDA).

V. Field Blanks

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on an associated project sample. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

VII. Duplicate Sample Analysis

The laboratory has indicated that there were no duplicate (DUP) analyses specified for the samples in this SDG, and therefore duplicate analyses were not performed for this SDG.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) and laboratory control samples duplicates (LCSD) were analyzed as required by the method. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

IX. Field Duplicates

Samples 0428-WSW02-2 and 0428-WSW06-2 were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

Analyte	Activity (ug/L)		RPD (Limits)	Flag	A or P
	0428-WSW02-2	0428-WSW06-2			
Total Uranium	0.188U	0.235	22 (≤50)	J (all detects) UJ (all non-detects)	A

X. Minimum Detectable Concentration

All minimum detectable concentration (MDC) met reporting limits (RL).

XI. Sample Result Verification

All sample result verifications were acceptable.

XII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

Due to field duplicate RPD, data were qualified as estimated in two samples.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

Phase 2 Water-Supply Well Sampling
Total Uranium - Data Qualification Summary - SDG 30222947

Sample	Isotope	Flag	A or P	Reason
0428-WSW02-2 0428-WSW06-2	Total Uranium	J (all detects) UJ (all non-detects)	A	Field duplicates (RPD)

Phase 2 Water-Supply Well Sampling
Total Uranium - Laboratory Blank Data Qualification Summary - SDG 30222947

No Sample Data Qualified in this SDG

Phase 2 Water-Supply Well Sampling
Total Uranium - Field Blank Data Qualification Summary - SDG 30222947

No Sample Data Qualified in this SDG

LDC #: 39328A59a **VALIDATION COMPLETENESS WORKSHEET**

SDG #: 30222947

Level IV

Laboratory: Pace Analytical Services, LLC

Date: 9-5-17

Page: 1 of 1

Reviewer: MG

2nd Reviewer: **METHOD:** Total Uranium (ASTM D5174-97)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	Initial calibration	A	
III.	Calibration verification	A	
IV.	Laboratory Blanks	A	
V.	Field blanks	N	
VI.	Matrix Spike/Matrix Spike Duplicates	A	MS / MSD
VII.	Duplicates	N	
VIII.	Laboratory control samples	A	LCS / LCSD
IX.	Field duplicates	SW	D = 2 + 6
X.	Tracer Recovery		
XI.	Minimum detectable activity (MDA)	A	
XII.	Sample result verification	A	
XIII.	Overall assessment of data	A	

Note: A = Acceptable
N = Not provided/applicable
SW = See worksheet

ND = No compounds detected
R = Rinsate
FB = Field blank

D = Duplicate
TB = Trip blank
EB = Equipment blank

SB = Source blank
OTHER:

	Client ID	Lab ID	Matrix	Date
1	0428-WSW01-2	30222947001	Water	06/27/17
2	0428-WSW02-2	30222947002	Water	06/27/17
3	0428-WSW03-2	30222947003	Water	06/28/17
4	0428-WSW04-2	30222947004	Water	06/28/17
5	0428-WSW05-2	30222947005	Water	06/27/17
6	0428-WSW06-2	30222947006	Water	06/27/17
7	0428-WSW07-2	30222947007	Water	06/27/17
8	0428-WSW07-2MS	30222947007MS	Water	06/27/17
9	0428-WSW07-2MSD	30222947007MSD	Water	06/27/17
10				
11				
12				
13				
14	PBW			

Notes: _____

LDC #: 39328A59a

VALIDATION FINDINGS CHECKLIST

Page: 1 of 2
Reviewer: MG
2nd Reviewer: Q**Method:**Metals (EPA SW 846 Method 6010/7000/6020)

Validation Area	Yes	No	NA	Findings/Comments
I. Technical holding times				
All technical holding times were met.	✓			
Cooler temperature criteria was met.	✓			
II. ICP/MS Tune				
Were all isotopes in the tuning solution mass resolution within 0.1 amu?			✓	
Were %RSD of isotopes in the tuning solution ≤5%?			✓	
III. Calibration				
Were all instruments calibrated daily, each set-up time?	✓			
Were the proper number of standards used?	✓			
Were all initial and continuing calibration verification %Rs within the 90-110% (80-120% for mercury) QC limits?			✓	
Were all initial calibration correlation coefficients > 0.995?	✓			
IV. Blanks				
Was a method blank associated with every sample in this SDG?	✓			
Was there contamination in the method blanks? If yes, please see the Blanks validation completeness worksheet.		✓		
V. ICP Interference Check Sample				
Were ICP interference check samples performed daily?		✓		
Were the AB solution percent recoveries (%R) with the 80-120% QC limits?			✓	
VI. Matrix spike/Matrix spike duplicates				
Were a matrix spike (MS) and duplicate (DUP) analyzed for each matrix in this SDG? If no, indicate which matrix does not have an associated MS/MSD or MS/DUP. Soil / Water.	✓			
Were the MS/MSD percent recoveries (%R) and the relative percent differences (RPD) within the 75-125 QC limits? If the sample concentration exceeded the spike concentration by a factor of 4 or more, no action was taken.	✓			
Were the MS/MSD or duplicate relative percent differences (RPD) ≤ 20% for waters and ≤ 35% for soil samples? A control limit of +/- RL (+/-2X RL for soil) was used for samples that were ≤ 5X the RL, including when only one of the duplicate sample values were < 5X the RL.	✓			
VII. Laboratory control samples				
Was an LCS analyzed for this SDG?	✓			
Was an LCS analyzed per extraction batch?	✓			
Were the LCS percent recoveries (%R) and relative percent difference (RPD) within the 80-120% QC limits for water samples and laboratory established QC limits for soils?	✓			

LDC #: 39328A59a

VALIDATION FINDINGS CHECKLIST

Page: 2 of 2
Reviewer: MG
2nd Reviewer: MF

Validation Area	Yes	No	NA	Findings/Comments
VIII. Internal Standards (EPA SW 846 Method 6020/EPA 200.8)				
Were all the percent recoveries (%R) within the 30-120% (6020)/60-125% (200.8) of the intensity of the internal standard in the associated initial calibration?			✓	
If the %Rs were outside the criteria, was a reanalysis performed?			✓	
IX. ICP Serial Dilution				
Was an ICP serial dilution analyzed if analyte concentrations were > 50X the MDL (ICP)/>100X the MDL(ICP/MS)?		✓		
Were all percent differences (%Ds) < 10%?			✓	
Was there evidence of negative interference? If yes, professional judgement will be used to qualify the data.			✓	
X. Sample Result Verification				
Were RLs adjusted to reflect all sample dilutions and dry weight factors applicable to level IV validation?	✓			
XI. Overall assessment of data				
Overall assessment of data was found to be acceptable.	✓			
XII. Field duplicates				
Field duplicate pairs were identified in this SDG.	✓			
Target analytes were detected in the field duplicates.	✓			
XIII. Field blanks				
Field blanks were identified in this SDG.		✓		
Target analytes were detected in the field blanks.			✓	

LDC#: 39328A59a**VALIDATION FINDINGS WORKSHEET**
Field DuplicatesPage: 1 of 1Reviewer: MG2nd Reviewer: MG**METHOD:** Metals (ASTM D5174-97)Y N NA
Y N NA

Were field duplicate pairs identified in this SDG?

Were target analytes detected in the field duplicate pairs?

Analyte	Concentration (ug/L)		RPD (≤ 20)	Qual. (Parent Only)
	2	6		
Total Uranium	0.188U	0.235	22	J/UJ/A (det & ND)

V:\FIELD DUPLICATES\Field Duplicates\FD_inorganic\2017\39328A59a.WPD

LDC #: 39328A59a

VALIDATION FINDINGS WORKSHEET

Level IV Recalculation Worksheet

Page: 1 of 1
Reviewer: MG
2nd Reviewer: Q

METHOD: Trace Metals (EPA SW 846 Method 6010/6020/7000)

Percent recoveries (%R) for an ICP interference check sample, a laboratory control sample and a matrix spike sample were recalculated using the following formula:

$\%R = \frac{\text{Found}}{\text{True}} \times 100$

Where, Found = Concentration of each analyte measured in the analysis of the sample. For the matrix spike calculation,
Found = SSR (spiked sample result) - SR (sample result).
True = Concentration of each analyte in the source.

A sample and duplicate relative percent difference (RPD) was recalculated using the following formula:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where, S = Original sample concentration
D = Duplicate sample concentration

An ICP serial dilution percent difference (%D) was recalculated using the following formula:

$\%D = \frac{|I-SDR|}{I} \times 100$

Where, I = Initial Sample Result (mg/L)
SDR = Serial Dilution Result (mg/L) (Instrument Reading x 5)

Sample ID	Type of Analysis	Element	Found / S / I (units)	True / D / SDR (units)	Recalculated	Reported	Acceptable (Y/N)
					%R / RPD / %D	%R / RPD / %D	
—	ICP interference check	—	—	—	—	—	—
LCS	Laboratory control sample	Tot. U	2.938 (µg/L)	2.720 (µg/L)	108.01	108.01	Y
8	Matrix spike	Tot. U	(SSR-SR) 5.771 (µg/L)	5.440 (µg/L)	106.1	106.1	↓
8/9	Duplicate	Tot. U	6.323 (µg/L)	6.547 (µg/L)	3.48	3.48	↓
—	ICP serial dilution	—	—	—	—	—	—

Comments: Refer to appropriate worksheet for list of qualifications and associated samples when reported results do not agree within 10.0% of the recalculated results.

LDC #: 39328A59a

VALIDATION FINDINGS WORKSHEET

Sample Calculation Verification

Page: 1 of 1
Reviewer: MG
2nd reviewer:

METHOD: Trace Metals (EPA SW 846 Method 6010/6020/7000)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

Y N N/A Have results been reported and calculated correctly?

☒ N N/A Are results within the calibrated range of the instruments and within the linear range of the ICP?

Are all detection limits below the CRDL?

Detected analyte results for # 3, Total u were recalculated and verified using the following equation:

$$\text{Concentration} = \frac{(\text{RD})(\text{FV})(\text{Dil})}{(\text{In. Vol.})}$$

Recalculation:

RD	=	Raw data concentration
FV	=	Final volume (ml)
In. Vol.	=	Initial volume (ml) or weight (G)
Dil	=	Dilution factor

$$\frac{(0.282 \text{ mg/L})(0.010 \text{ L})}{0.010 \text{ L}} = 0.282 \text{ mg/L}$$

[illegible]

Note: Method ASTM D5174-97 is N.D. for samples 1, 2 and 4

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Phase 2 Water-Supply Well Sampling

LDC Report Date: September 7, 2017

Parameters: Isotopic Uranium

Validation Level: Level IV

Laboratory: Pace Analytical Services, LLC

Sample Delivery Group (SDG): 30222947

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
0428-WSW01-2	30222947001	Water	06/27/17
0428-WSW02-2	30222947002	Water	06/27/17
0428-WSW03-2	30222947003	Water	06/28/17
0428-WSW04-2	30222947004	Water	06/28/17
0428-WSW05-2	30222947005	Water	06/27/17
0428-WSW06-2	30222947006	Water	06/27/17
0428-WSW07-2	30222947007	Water	06/27/17
0428-WSW07-2MS	30222947007MS	Water	06/27/17
0428-WSW07-2MSD	30222947007MSD	Water	06/27/17

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Uniform Federal Policy – Quality Assurance Project Plan for Water Supply Well Sampling – Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York (June 2017), the Multi Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual (July 2004), and a modified outline of the USEPA National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review (January 2017). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Isotopic Uranium by HASL-300

All sample results were subjected to Level IV data validation, which is comprised of the quality control (QC) summary forms as well as the raw data, to confirm sample quantitation and identification.

The following are definitions of the data qualifiers utilized during data validation:

- J+ (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.
- J- (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.
- J (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to non-conformances discovered during data validation. Bias is indeterminate.
- U (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however the compound or analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- N (Presumptive): The analysis indicates the presence of a compound or analyte that has been "tentatively identified."
- NJ (Presumptive and estimated): The analysis indicates the presence of a compound or analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- R (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.
- NA (Not Applicable): The non-conformance discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant the qualification of the data.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Initial Calibration

All criteria for the initial calibration were met.

Counting and detector efficiency were determined for each detector and each radionuclide.

III. Continuing Calibration

Continuing calibration and background determination were performed at the required frequencies. Results were within laboratory control limits.

IV. Blanks

Laboratory blanks were analyzed as required by the method. Blank results contained less than the minimum detectable activity (MDA).

V. Field Blanks

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

Matrix spike (MS) and matrix spike duplicate (MSD) sample analysis was performed on an associated project sample. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

VII. Duplicate Sample Analysis

The laboratory has indicated that there were no duplicate (DUP) analyses specified for the samples in this SDG, and therefore duplicate analyses were not performed for this SDG.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) and laboratory control samples duplicates (LCSD) were analyzed as required by the method. Percent recoveries (%R) were within QC limits. Relative percent differences (RPD) were within QC limits.

IX. Field Duplicates

Samples 0428-WSW02-2 and 0428-WSW06-2 were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

Isotope	Activity (pCi/L)		RPD (Limits)	Flag	A or P
	0428-WSW02-2	0428-WSW06-2			
Uranium-234	0.237	0.083U	96 (≤50)	J (all detects) UJ (all non-detects)	A

X. Tracer Recovery

All tracer recoveries were within validation criteria.

XI. Minimum Detectable Concentration

All minimum detectable concentration (MDC) met reporting limits (RL).

XII. Sample Result Verification

All sample result verifications were acceptable.

XIII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

Due to field duplicate RPD, data were qualified as estimated in two samples.

The quality control criteria reviewed, other than those discussed above, were met and are considered acceptable. Sample results that were found to be estimated (J) are usable for limited purposes only. Based upon the data validation all other results are considered valid and usable for all purposes.

**Phase 2 Water-Supply Well Sampling
Isotopic Uranium - Data Qualification Summary - SDG 30222947**

Sample	Isotope	Flag	A or P	Reason
0428-WSW02-2 0428-WSW06-2	Uranium-234	J (all detects) UJ (all non-detects)	A	Field duplicates (RPD)

**Phase 2 Water-Supply Well Sampling
Isotopic Uranium - Laboratory Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Isotopic Uranium - Field Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

LDC #: 39328A59b **VALIDATION COMPLETENESS WORKSHEET**
SDG #: 30222947 Level IV
Laboratory: Pace Analytical Services, LLC

Date: 9-5-17
Page: 1 of 1
Reviewer: MG
2nd Reviewer:

METHOD: Isotopic Uranium (HASL-300)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	Initial calibration	A	
III.	Calibration verification	A	
IV.	Laboratory Blanks	A	PB only
V.	Field blanks	N	
VI.	Matrix Spike/Matrix Spike Duplicates	A	MS/MSD
VII.	Duplicates	N	client specified
VIII.	Laboratory control samples	A	LCS/LCSD
IX.	Field duplicates	SW	D = 2 + 6
X.	Tracer Recovery	A	
XI.	Minimum detectable activity (MDA)	A	
XII.	Sample result verification	A	
XIII.	Overall assessment of data	A	

Note: A = Acceptable
N = Not provided/applicable
SW = See worksheet

ND = No compounds detected
R = Rinsate
FB = Field blank

D = Duplicate
TB = Trip blank
EB = Equipment blank

SB=Source blank
OTHER:

	Client ID	Lab ID	Matrix	Date
1	0428-WSW01-2	30222947001	Water	06/27/17
2	0428-WSW02-2	30222947002	Water	06/27/17
3	0428-WSW03-2	30222947003	Water	06/28/17
4	0428-WSW04-2	30222947004	Water	06/28/17
5	0428-WSW05-2	30222947005	Water	06/27/17
6	0428-WSW06-2	30222947006	Water	06/27/17
7	0428-WSW07-2	30222947007	Water	06/27/17
8	0428-WSW07-2MS	30222947007MS	Water	06/27/17
9	0428-WSW07-2MSD	30222947007MSD	Water	06/27/17
10				
11				
12				
13				
14	PBW			

Notes:

HASL-300

Method: Radiochemistry(EPA Method)

Validation Area	Yes	No	NA	Findings/Comments
I. Technical holding times				
All technical holding times were met.	✓			
II. Calibration				
Were all instruments and detectors calibration as required?	✓			
Were NIST traceable standards used for all calibrations?	✓			
Was the check source identified by activity and radionuclide?	✓			
Were check sources including background counts analyzed at the required frequency and within laboratory control limits?	✓			
III. Blanks				
Were blank analyses performed as required?	✓			
Were any activities detected in the blanks greater than the minimum detectable activity (MDA)? If yes, please see the Blanks validation completeness worksheet.		✓		
IV. Matrix spikes and Duplicates				
Were a matrix spike (MS) analyzed for each matrix in this SDG? If no, indicate which matrix does not have an associated MS/MSD or MS/DUP. Soil / Water.	✓			
Were the MS percent recoveries (%R) within the QC limits? If the sample concentration exceeded the spike concentration by a factor of 4 or more, no action was taken.	✓			
Was a duplicate sample analyzed at the required frequency of 5% in this SDG?		✓		
Were all duplicate sample duplicate error ratios (DER) <1.42?			✓	
V. Laboratory control samples				
Was an LCS analyzed per analytical batch?	✓			
Were the LCS percent recoveries (%R) and relative percent difference (RPD) within the 75-125%	✓			
VI. Sample Chemical/Carrier Recovery				
Was a tracer/carrier added to each sample?	✓			
Were tracer/carrier recoveries within the QC limits?	✓			
VII. Regional Quality Assurance and Quality Control				
Were performance evaluation (PE) samples performed?		✓		
Were the performance evaluation (PE) samples within the acceptance limits?			✓	
VIII. Sample Result Verification				
Were activities adjusted to reflect all sample dilutions and dry weight factors applicable to level IV validation?	✓			
Were the Minimum Detectable Activities (MDA) < RL?	✓			

LDC #: 39328A59b

VALIDATION FINDINGS CHECKLIST

Page: 2 of 2
Reviewer: MG
2nd Reviewer: Q

Validation Area	Yes	No	NA	Findings/Comments
IX. Overall assessment of data				
Overall assessment of data was found to be acceptable.	✓			
X. Field duplicates				
Field duplicate pairs were identified in this SDG.	✓			
Target analytes were detected in the field duplicates.	✓			
XI. Field blanks				
Field blanks were identified in this SDG.		✓		
Target analytes were detected in the field blanks.			✓	

LDC# 39328A59b

VALIDATION FINDINGS WORKSHEET
Field Duplicates

Page: 1 of 1
Reviewer: MG
2nd Reviewer: Q

Radiochemistry, Method HASL-300

Isotope	Activity (pCi/L)		RPD (≤ 50)	Qualification (Parent Only)
	2	6		
U-234	0.237	0.083U	96	J/UJ/A (det & ND)

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LDC #: 39328A596

VALIDATION FINDINGS WORKSHEET **Level IV Recalculation Worksheet**

Page: 1 of 1Reviewer: MG2nd Reviewer: QMETHOD: Radiochemistry (Method: HASL-300)

Percent recoveries (%R) for a laboratory control sample, a matrix spike and a matrix spike duplicate sample were recalculated using the following formula:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where, Found = activity of each analyte measured in the analysis of the sample.
 True = activity of each analyte in the source.

A matrix spike and matrix spike duplicate relative percent difference (RPD) was recalculated using the following formula:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where, S = Original sample activity
 D = Duplicate sample activity

Sample ID	Type of Analysis	Analyte	Found/S (units)	True/D (units)	Recalculated	Reported	Acceptable (Y/N)
					%R or RPD	%R or RPD	
LCS	Laboratory control sample	U-234	13.40 (pCi/L)	13.71 (pCi/L)	97.74	97.76	Y
8	Matrix spike sample	U-238	26.89 (pCi/L)	29.19 (pCi/L)	92.1	92.1	
8/9	Duplicate RPD	U-234	27.70 (pCi/L)	26.80 (pCi/L)	3.30	* 0.22	
1	Chemical recovery	U-232	18.71 (dpm)	20.34 (dpm)	92	92	

Comments: * Lab uses % recovery to calculate RPD, not sample activity

Laboratory Data Consultants, Inc.
Data Validation Report

Project/Site Name: Phase 2 Water-Supply Well Sampling

LDC Report Date: September 7, 2017

Parameters: Radon

Validation Level: Level IV

Laboratory: Pace Analytical Services, LLC

Sample Delivery Group (SDG): 30222947

Sample Identification	Laboratory Sample Identification	Matrix	Collection Date
0428-WSW01-2	30222947001	Water	06/27/17
0428-WSW02-2	30222947002	Water	06/27/17
0428-WSW03-2	30222947003	Water	06/28/17
0428-WSW04-2	30222947004	Water	06/28/17
0428-WSW05-2	30222947005	Water	06/27/17
0428-WSW06-2	30222947006	Water	06/27/17
0428-WSW07-2	30222947007	Water	06/27/17

Introduction

This Data Validation Report (DVR) presents data validation findings and results for the associated samples listed on the cover page. Data validation was performed in accordance with the Uniform Federal Policy – Quality Assurance Project Plan for Water Supply Well Sampling – Phase 2, Canadian Radium & Uranium Corp., Mount Kisco, New York (June 2017), the Multi Agency Radiological Laboratory Analytical Protocols (MARLAP) Manual (July 2004), and a modified outline of the USEPA National Functional Guidelines (NFG) for Inorganic Superfund Methods Data Review (January 2017). Where specific guidance was not available, the data has been evaluated in a conservative manner consistent with industry standards using professional experience.

The analyses were performed by the following method:

Radon by Standard Method 7500-RNB-07

All sample results were subjected to Level IV data validation, which is comprised of the quality control (QC) summary forms as well as the raw data, to confirm sample quantitation and identification.

The following are definitions of the data qualifiers utilized during data validation:

- J+ (Estimated, High Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying high bias, due to non-conformances discovered during data validation.
- J- (Estimated, Low Bias): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated, displaying low bias, due to non-conformances discovered during data validation.
- J (Estimated, Bias Indeterminate): The compound or analyte was analyzed for and positively identified by the laboratory; however the reported concentration is estimated due to non-conformances discovered during data validation. Bias is indeterminate.
- U (Non-detected): The compound or analyte was analyzed for and positively identified by the laboratory; however the compound or analyte should be considered non-detected at the reported concentration due to the presence of contaminants detected in the associated blank(s).
- UJ (Non-detected estimated): The compound or analyte was reported as not detected by the laboratory; however the reported quantitation/detection limit is estimated due to non-conformances discovered during data validation.
- N (Presumptive): The analysis indicates the presence of a compound or analyte that has been "tentatively identified."
- NJ (Presumptive and estimated): The analysis indicates the presence of a compound or analyte that has been "tentatively identified" and the associated numerical value represents its approximate concentration.
- R (Rejected): The sample results were rejected due to gross non-conformances discovered during data validation. Data qualified as rejected is not usable.
- NA (Not Applicable): The non-conformance discovered during data validation demonstrates a high bias, while the affected compound or analyte in the associated sample(s) was reported as not detected by the laboratory and did not warrant the qualification of the data.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

I. Sample Receipt and Technical Holding Times

All samples were received in good condition.

All technical holding time requirements were met.

II. Initial Calibration

All criteria for the initial calibration were met.

Counting and detector efficiency were determined for each detector and each radionuclide.

III. Continuing Calibration

Continuing calibration and background determination were performed at the required frequencies. Results were within laboratory control limits.

IV. Blanks

Laboratory blanks were analyzed as required by the method. Blank results contained less than the minimum detectable activity (MDA).

V. Field Blanks

No field blanks were identified in this SDG.

VI. Matrix Spike/Matrix Spike Duplicates

The laboratory has indicated that there were no matrix spike (MS) and matrix spike duplicate (MSD) analyses specified for the samples in this SDG, and therefore matrix spike and matrix spike duplicate analyses were not performed for this SDG.

VII. Duplicate Sample Analysis

The laboratory has indicated that there were no duplicate (DUP) analyses specified for the samples in this SDG, and therefore duplicate analyses were not performed for this SDG.

VIII. Laboratory Control Samples

Laboratory control samples (LCS) were analyzed as required by the method. Percent recoveries (%R) were within QC limits.

IX. Field Duplicates

Samples 0428-WSW02-2 and 0428-WSW06-2 were identified as field duplicates. No results were detected in any of the samples with the following exceptions:

Isotope	Activity (pCi/L)		RPD (Limits)	Flag	A or P
	0428-WSW02-2	0428-WSW06-2			
Radon-222	793	772	3 (≤ 50)	-	-

X. Minimum Detectable Concentration

All minimum detectable concentration (MDC) met reporting limits (RL).

XI. Sample Result Verification

All sample result verifications were acceptable.

XII. Overall Assessment of Data

The analysis was conducted within all specifications of the method. No results were rejected in this SDG.

The quality control criteria reviewed were met and are considered acceptable. Based upon the data validation all results are considered valid and usable for all purposes.

**Phase 2 Water-Supply Well Sampling
Radon - Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Radon - Laboratory Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

**Phase 2 Water-Supply Well Sampling
Radon - Field Blank Data Qualification Summary - SDG 30222947**

No Sample Data Qualified in this SDG

LDC #: 39328A78 **VALIDATION COMPLETENESS WORKSHEET**
SDG #: 30222947 Level IV
Laboratory: Pace Analytical Services, LLC

Date: 9-5-17
Page: 1 of 1
Reviewer: MG
2nd Reviewer: Q

METHOD: Radon (SM7500-RnB-07)

The samples listed below were reviewed for each of the following validation areas. Validation findings are noted in attached validation findings worksheets.

	Validation Area		Comments
I.	Sample receipt/Technical holding times	A	
II.	Initial calibration	A	
III.	Calibration verification	A	
IV.	Laboratory Blanks	A	PB only
V.	Field blanks	N	
VI.	Matrix Spike/Matrix Spike Duplicates	N	not required
VII.	Duplicates	N	client specified
VIII.	Laboratory control samples	A	LCS
IX.	Field duplicates	SW	D=2+6
X.	Tracer Recovery		
XI.	Minimum detectable activity (MDA)	A	
XII.	Sample result verification	A	
XIII.	Overall assessment of data	A	

Note: A = Acceptable
N = Not provided/applicable
SW = See worksheet

ND = No compounds detected
R = Rinsate
FB = Field blank

D = Duplicate
TB = Trip blank
EB = Equipment blank

SB=Source blank
OTHER:

	Client ID	Lab ID	Matrix	Date
1	0428-WSW01-2	30222947001	Water	06/27/17
2	0428-WSW02-2	30222947002	Water	06/27/17
3	0428-WSW03-2	30222947003	Water	06/28/17
4	0428-WSW04-2	30222947004	Water	06/28/17
5	0428-WSW05-2	30222947005	Water	06/27/17
6	0428-WSW06-2	30222947006	Water	06/27/17
7	0428-WSW07-2	30222947007	Water	06/27/17
8				
9				
10				
11				
12				
13				
14	PBW			

Notes:

SM7500-RnB-07

Method: Radiochemistry (EPA Method)

Validation Area	Yes	No	NA	Findings/Comments
I. Technical holding times				
All technical holding times were met.	✓			
II. Calibration				
Were all instruments and detectors calibration as required?	✓			
Were NIST traceable standards used for all calibrations?	✓			
Was the check source identified by activity and radionuclide?	✓			
Were check sources including background counts analyzed at the required frequency and within laboratory control limits?	✓			
III. Blanks				
Were blank analyses performed as required?	✓			
Were any activities detected in the blanks greater than the minimum detectable activity (MDA)? If yes, please see the Blanks validation completeness worksheet.		✓		
IV. Matrix spikes and Duplicates				
Were a matrix spike (MS) analyzed for each matrix in this SDG? If no, indicate which matrix does not have an associated MS/MSD or MS/DUP. Soil / Water.		✓		
Were the MS percent recoveries (%R) within the QC limits? If the sample concentration exceeded the spike concentration by a factor of 4 or more, no action was taken.			✓	
Was a duplicate sample analyzed at the required frequency of 5% in this SDG?		✓		
Were all duplicate sample duplicate error ratios (DER) ≤1.42?			✓	
V. Laboratory control samples				
Was an LCS analyzed per analytical batch?	✓			
Were the LCS percent recoveries (%R) and relative percent difference (RPD) within the 75-125%	✓			
VI. Sample Chemical/Carrier Recovery				
Was a tracer/carrier added to each sample?		✓		
Were tracer/carrier recoveries within the QC limits?			✓	
VII. Regional Quality Assurance and Quality Control				
Were performance evaluation (PE) samples performed?		✓		
Were the performance evaluation (PE) samples within the acceptance limits?			✓	
VIII. Sample Result Verification				
Were activities adjusted to reflect all sample dilutions and dry weight factors applicable to level IV validation?	✓			
Were the Minimum Detectable Activities (MDA) < RL?	✓			

LDC #: 39328A78

VALIDATION FINDINGS CHECKLIST

Page: 2 of 2
Reviewer: MS
2nd Reviewer: [Signature]

Validation Area	Yes	No	NA	Findings/Comments
IX. Overall assessment of data				
Overall assessment of data was found to be acceptable.	✓			
X. Field duplicates				
Field duplicate pairs were identified in this SDG.	✓			
Target analytes were detected in the field duplicates.	✓			
XI. Field blanks				
Field blanks were identified in this SDG.		✓		
Target analytes were detected in the field blanks.			✓	

LDC# 39328A78

VALIDATION FINDINGS WORKSHEET
Field Duplicates

Page: 1 of 1
Reviewer: MG
2nd Reviewer: CD

Radiochemistry, Method SM7500-RnB-07

Isotope	Activity (pCi/L)		RPD (≤ 50)	Qualification (Parent Only)
	2	6		
Rn-222	793	772	3	

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LDC #: 39328A78

VALIDATION FINDINGS WORKSHEET **Level IV Recalculation Worksheet**

Page: 1 of 1Reviewer: MG2nd Reviewer: QMETHOD: Radiochemistry (Method: SM7500-RnB-07)

Percent recoveries (%R) for a laboratory control sample, a matrix spike and a matrix spike duplicate sample were recalculated using the following formula:

$$\%R = \frac{\text{Found}}{\text{True}} \times 100$$

Where, Found = activity of each analyte measured in the analysis of the sample.
 True = activity of each analyte in the source.

A matrix spike and matrix spike duplicate relative percent difference (RPD) was recalculated using the following formula:

$$RPD = \frac{|S-D|}{(S+D)/2} \times 100$$

Where, S = Original sample activity
 D = Duplicate sample activity

Sample ID	Type of Analysis	Analyte	Found/S (units)	True/D (units)	Recalculated	Reported	Acceptable (Y/N)
					%R or RPD	%R or RPD	
LC S1	Laboratory control sample	Rn-222	10845 (pCi/L)	11761 (pCi/L)	92.21	92.21	Y
—	Matrix spike sample	—	—	—	—	—	—
—	Duplicate RPD	—	—	—	—	—	—
—	Chemical recovery	—	—	—	—	—	—

Comments: _____

LDC #: 39328A78

VALIDATION FINDINGS WORKSHEET Sample Calculation Verification

Page: 1 of 1Reviewer: MG2nd reviewer: [Signature]METHOD: Radiochemistry (Method: SM7500-RnB-07)

Please see qualifications below for all questions answered "N". Not applicable questions are identified as "N/A".

☒ Y ☐ N N/A

Have results been reported and calculated correctly?

☒ Y ☐ N N/A

Are results within the calibrated range of the instruments?

Analyte results for # 1, Rn-222 reported with a positive detect were recalculated and verified using the following equation:

Concentration =

Recalculation:

$$\frac{(\text{cpm} - \text{background})}{2.22 \times E \times SA \times \text{Vol}}$$

E = Counter Efficiency

SA = Self-absorbance factor

Vol = Volume of sample

$$\frac{(24.09 \text{ cpm}) - (7.44 \text{ cpm})}{(2.22)(2.074)(0.015 \text{ L})} \times \frac{1}{0.6532} = 369.08 \text{ pCi/L}$$

#	Sample ID	Analyte	Reported Concentration (pCi/L)	Calculated Concentration (pCi/L)	Acceptable (Y/N)
1	1	Rn-222	369.1	369.1	Y
2	2		793	793.3	
3	3		1491	1491	
4	4		1108	1108	
5	5		1675	1675	
6	6		772	772.3	
7	7		1949	1949	

Note: _____

30222947

InternalWorkOrder	InternalID	LabCode	ClientName	SampleDate	LogTime	DateReceived	PrepDate	CountDate	AnaTime	Run	SampNo
30222947	1301840	PacG	Weston	7/10/2017	13:50		7/10/2017	7/19/2017	16:07		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/10/2017	7/21/2017	11:51		1
30222947	30222947001MS	PacG	Weston	7/10/2017	13:50		7/10/2017	7/21/2017	12:19		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/10/2017	7/21/2017	11:53		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/10/2017	7/21/2017	11:55		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/10/2017	7/21/2017	11:57		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/10/2017	7/21/2017	11:59		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/10/2017	7/21/2017	12:02		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/10/2017	7/21/2017	12:04		1
30222947	30222947008	PacG	Weston	7/10/2017	13:50		7/10/2017	7/21/2017	12:06		1
30222947	30222947009	PacG	Weston	7/10/2017	13:50		7/10/2017	7/21/2017	12:08		1
	30223367001	PacG	Weston	7/10/2017			7/10/2017	7/19/2017	16:09		1
30222947	30223367001MS	PacG	Weston	7/10/2017	13:50		7/10/2017	7/19/2017	16:13		1
30222947	LCS36540	PacG	Weston	7/10/2017	13:50		7/10/2017	7/19/2017	16:26		1
30222947	LCSD36540	PacG	Weston	7/10/2017	13:50		7/10/2017	7/19/2017	16:56		1
30222947	1299304	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:38		1
30222947	1299304	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:38		1
30222947	1299304	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:38		1
30222947	1299304	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:38		1
30222947	1299304	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:38		1
30222947	1299304	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:38		1
30222947	1299304	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:38		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299305	PacG	Weston			6/30/2017	6/30/2017	7/3/2017	15:42		1
30222947	1299309	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:46		1
30222947	1299309	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:46		1
30222947	1299309	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:46		1
30222947	1299309	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:46		1
30222947	1299309	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:46		1
30222947	1299309	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:46		1
30222947	1299309	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:46		1

SBD	SED	Matrix	SampleType	AnalysisCode	ClientID	Isotope	Method	ReportUnits	Result	Uncertainty	RL
0	0	Water	BLANK	TU		Total Uranium	ASTM D5174-97	ug/L	0.043	0.002	0.193
0	0	Water	REG	TU	0428-WSW01-2	Total Uranium	ASTM D5174-97	ug/L	0.192	0.007	0.193
0	0	Water	MS	TU		Total Uranium	ASTM D5174-97	µg/l	8.66	0.215	0.197
0	0	Water	REG	TU	0428-WSW02-2	Total Uranium	ASTM D5174-97	ug/L	0.188	0.006	0.193
0	0	Water	REG	TU	0428-WSW03-2	Total Uranium	ASTM D5174-97	ug/L	0.282	0.009	0.193
0	0	Water	REG	TU	0428-WSW04-2	Total Uranium	ASTM D5174-97	ug/L	0.177	0.007	0.193
0	0	Water	REG	TU	0428-WSW05-2	Total Uranium	ASTM D5174-97	ug/L	4.26	0.106	0.193
0	0	Water	REG	TU	0428-WSW06-2	Total Uranium	ASTM D5174-97	ug/L	0.235	0.008	0.193
0	0	Water	REG	TU	0428-WSW07-2	Total Uranium	ASTM D5174-97	ug/L	0.816	0.024	0.193
0	0	Water	MS	TU		Total Uranium	ASTM D5174-97	µg/l	9.34	0.231	0.197
0	0	Water	MS	TU		Total Uranium	ASTM D5174-97	µg/l	9.67	0.241	0.197
0	0	Drinking Water	REG	TU		Total Uranium	ASTM D5174-97	µg/l	0.214	0.00808	0.197
0	0	Water	MS	TU		Total Uranium	ASTM D5174-97	µg/l	8.96	0.291	0.197
0	0	Water	LCS	TU		Total Uranium	ASTM D5174-97	µg/l	4.34	0.142	0.197
0	0	Water	LCSD	TU		Total Uranium	ASTM D5174-97	µg/l	4.51	0.147	0.197
0	0	Water	BLANK		263861 BLANK 1299304	Aluminum	EPA 200.7	ug/L	50.0		50.0
0	0	Water	BLANK		263861 BLANK 1299304	Copper	EPA 200.7	ug/L	5.0		5.0
0	0	Water	BLANK		263861 BLANK 1299304	Iron	EPA 200.7	ug/L	70.0		70.0
0	0	Water	BLANK		263861 BLANK 1299304	Lead	EPA 200.7	ug/L	5.0		5.0
0	0	Water	BLANK		263861 BLANK 1299304	Manganese	EPA 200.7	ug/L	1.8		5.0
0	0	Water	BLANK		263861 BLANK 1299304	Potassium	EPA 200.7	ug/L	500		500
0	0	Water	BLANK		263861 BLANK 1299304	Zinc	EPA 200.7	ug/L	1.1		10.0
0	0	Water	LCS		263861 LCS 1299305	Aluminum	EPA 200.7	ug/L	5170		50.0
0	0	Water	LCS		263861 LCS 1299305	Copper	EPA 200.7	ug/L	521		5.0
0	0	Water	LCS		263861 LCS 1299305	Iron	EPA 200.7	ug/L	5150		70.0
0	0	Water	LCS		263861 LCS 1299305	Lead	EPA 200.7	ug/L	488		5.0
0	0	Water	LCS		263861 LCS 1299305	Manganese	EPA 200.7	ug/L	516		5.0
0	0	Water	LCS		263861 LCS 1299305	Potassium	EPA 200.7	ug/L	5210		500
0	0	Water	LCS		263861 LCS 1299305	Zinc	EPA 200.7	ug/L	518		10.0
0	0	Water	DUP		263861 DUP 1299309	Aluminum	EPA 200.7	ug/L	3840		50.0
0	0	Water	DUP		263861 DUP 1299309	Copper	EPA 200.7	ug/L	5.0		5.0
0	0	Water	DUP		263861 DUP 1299309	Iron	EPA 200.7	ug/L	23300		70.0
0	0	Water	DUP		263861 DUP 1299309	Lead	EPA 200.7	ug/L	5.0		5.0
0	0	Water	DUP		263861 DUP 1299309	Manganese	EPA 200.7	ug/L	8410		5.0
0	0	Water	DUP		263861 DUP 1299309	Potassium	EPA 200.7	ug/L	4760		500
0	0	Water	DUP		263861 DUP 1299309	Zinc	EPA 200.7	ug/L	223		10.0

MDA	Critical Level	LabQualifier	Batch	TracerKnown	TracerError	RadioPercentRec	GravPercentRec	TracerUpperLimit	TracerLowerLimit
0.193	0.036		RADC36540						
0.193	0.036		RADC36540						
0.197	0.036		RADC36540						
0.193	0.036		RADC36540						
0.193	0.036		RADC36540						
0.193	0.036		RADC36540						
0.193	0.036		RADC36540						
0.193	0.036		RADC36540						
0.193	0.036		RADC36540						
0.197	0.036		RADC36540						
0.197	0.036		RADC36540						
0.197	0.036		RADC36540						
0.197	0.036		RADC36540						
0.197	0.036		RADC36540						
0.197	0.036		RADC36540						
50.0			ICP263781						
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						
50.0			ICP263781						
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						
50.0			ICP263781						
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						

SpikeKnown	SpikeKnownError	SpikeRecovery	SpikeUpperLimit	SpikeLowerLimit	RPD_Value	RPDLimit	CAS	ValidationQualifier
							7440-61-1	
							7440-61-1	
5.44	0.192	105	125	75			7440-61-1	
							7440-61-1	UJ
							7440-61-1	
							7440-61-1	
							7440-61-1	
							7440-61-1	J
							7440-61-1	
5.44	0.192	106	125	75			7440-61-1	
5.44	0.192	110	125	75	3	25	7440-61-1	
							7440-61-1	
5.44	0.192	109	125	75			7440-61-1	
2.72	0.096	108	125	75			7440-61-1	
2.72	0.096	112	125	75		25	7440-61-1	
							7429-90-5	
							7440-50-8	
							7439-89-6	
							7439-92-1	
							7439-96-5	
							7440-09-7	
							7440-66-6	
5000		103	115	85			7429-90-5	
500		104	115	85			7440-50-8	
5000		103	115	85			7439-89-6	
500		98	115	85			7439-92-1	
500		103	115	85			7439-96-5	
5000		104	115	85			7440-09-7	
500		104	115	85			7440-66-6	
					8	20	7429-90-5	
						20	7440-50-8	
					8	20	7439-89-6	
						20	7439-92-1	
					8	20	7439-96-5	
					7	20	7440-09-7	
					4	20	7440-66-6	

InternalWorkOrder	InternalID	LabCode	ClientName	SampleDate	LogTime	DateReceived	PrepDate	CountDate	AnaTime	Run	SampNo
30222947	1299310	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:50		1
30222947	1299310	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:50		1
30222947	1299310	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:50		1
30222947	1299310	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:50		1
30222947	1299310	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:50		1
30222947	1299310	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:50		1
30222947	1299310	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:50		1
30222947	1299311	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:49		1
30222947	1299311	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:49		1
30222947	1299311	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:49		1
30222947	1299311	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:49		1
30222947	1299311	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:49		1
30222947	1299311	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:49		1
30222947	1299311	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:49		1
30222947	1299312	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:53		1
30222947	1299312	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:53		1
30222947	1299312	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:53		1
30222947	1299312	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:53		1
30222947	1299312	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:53		1
30222947	1299312	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:53		1
30222947	1299312	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:53		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	1299313	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	15:56		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	6/30/2017	7/3/2017	16:00		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	6/30/2017	7/3/2017	16:03		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	6/30/2017	7/3/2017	16:07		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	6/30/2017	7/3/2017	16:11		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	6/30/2017	7/3/2017	16:24		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	6/30/2017	7/3/2017	16:28		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	6/30/2017	7/3/2017	15:45		1
30222947	30223055003	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:42		1

SBD	SED	Matrix	SampleType	AnalysisCode	ClientID	Isotope	Method	ReportUnits	Result	Uncertainty	RL
0	0	Water	MS		263861 MS 1299310	Aluminum	EPA 200.7	ug/L	9400		50.0
0	0	Water	MS		263861 MS 1299310	Copper	EPA 200.7	ug/L	525		5.0
0	0	Water	MS		263861 MS 1299310	Iron	EPA 200.7	ug/L	29900		70.0
0	0	Water	MS		263861 MS 1299310	Lead	EPA 200.7	ug/L	500		5.0
0	0	Water	MS		263861 MS 1299310	Manganese	EPA 200.7	ug/L	9450		5.0
0	0	Water	MS		263861 MS 1299310	Potassium	EPA 200.7	ug/L	10400		500
0	0	Water	MS		263861 MS 1299310	Zinc	EPA 200.7	ug/L	730		10.0
0	0	Water	DUP		263861 DUP 1299311	Aluminum	EPA 200.7	ug/L	10.6		50.0
0	0	Water	DUP		263861 DUP 1299311	Copper	EPA 200.7	ug/L	5.0		5.0
0	0	Water	DUP		263861 DUP 1299311	Iron	EPA 200.7	ug/L	70.0		70.0
0	0	Water	DUP		263861 DUP 1299311	Lead	EPA 200.7	ug/L	5.0		5.0
0	0	Water	DUP		263861 DUP 1299311	Manganese	EPA 200.7	ug/L	5.0		5.0
0	0	Water	DUP		263861 DUP 1299311	Potassium	EPA 200.7	ug/L	5970		500
0	0	Water	DUP		263861 DUP 1299311	Zinc	EPA 200.7	ug/L	4.5		10.0
0	0	Water	MS		263861 MS 1299312	Aluminum	EPA 200.7	ug/L	5190		50.0
0	0	Water	MS		263861 MS 1299312	Copper	EPA 200.7	ug/L	529		5.0
0	0	Water	MS		263861 MS 1299312	Iron	EPA 200.7	ug/L	5100		70.0
0	0	Water	MS		263861 MS 1299312	Lead	EPA 200.7	ug/L	499		5.0
0	0	Water	MS		263861 MS 1299312	Manganese	EPA 200.7	ug/L	516		5.0
0	0	Water	MS		263861 MS 1299312	Potassium	EPA 200.7	ug/L	11300		500
0	0	Water	MS		263861 MS 1299312	Zinc	EPA 200.7	ug/L	514		10.0
0	0	Water	MSD		263861 MSD 1299313	Aluminum	EPA 200.7	ug/L	5300		50.0
0	0	Water	MSD		263861 MSD 1299313	Copper	EPA 200.7	ug/L	529		5.0
0	0	Water	MSD		263861 MSD 1299313	Iron	EPA 200.7	ug/L	5180		70.0
0	0	Water	MSD		263861 MSD 1299313	Lead	EPA 200.7	ug/L	500		5.0
0	0	Water	MSD		263861 MSD 1299313	Manganese	EPA 200.7	ug/L	515		5.0
0	0	Water	MSD		263861 MSD 1299313	Potassium	EPA 200.7	ug/L	11400		500
0	0	Water	MSD		263861 MSD 1299313	Zinc	EPA 200.7	ug/L	513		10.0
0	0	Water	REG		0428-WSW01-2	Potassium	EPA 200.7	ug/L	6210		500
0	0	Water	REG		0428-WSW02-2	Potassium	EPA 200.7	ug/L	4650		500
0	0	Water	REG		0428-WSW03-2	Potassium	EPA 200.7	ug/L	3870		500
0	0	Water	REG		0428-WSW04-2	Potassium	EPA 200.7	ug/L	4010		500
0	0	Water	REG		0428-WSW05-2	Potassium	EPA 200.7	ug/L	12200		500
0	0	Water	REG		0428-WSW06-2	Potassium	EPA 200.7	ug/L	4640		500
0	0	Water	REG		0428-WSW07-2	Potassium	EPA 200.7	ug/L	5880		500
0	0	Water	REG		263861 PS 1299014	Aluminum	EPA 200.7	ug/L	4170		50.0

MDA	Critical Level	LabQualifier	Batch	TracerKnown	TracerError	RadioPercentRec	GravPercentRec	TracerUpperLimit	TracerLowerLimit
50.0			ICP263781						
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						
50.0			ICP263781						
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						
50.0			ICP263781						
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						
50.0			ICP263781						
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						
500			ICP263781						
500			ICP263781						
500			ICP263781						
500			ICP263781						
500			ICP263781						
500			ICP263781						
500			ICP263781						
50.0			ICP263781						

SpikeKnown	SpikeKnownError	SpikeRecovery	SpikeUpperLimit	SpikeLowerLimit	RPD_Value	RPDLimit	CAS	ValidationQualifier
5000		105	130	70			7429-90-5	
500		105	130	70			7440-50-8	
5000		92	130	70			7439-89-6	
500		100	130	70			7439-92-1	
500		68	130	70			7439-96-5	
5000		106	130	70			7440-09-7	
500		100	130	70			7440-66-6	
						20	7429-90-5	
						20	7440-50-8	
						20	7439-89-6	
						20	7439-92-1	
						20	7439-96-5	
					1	20	7440-09-7	
						20	7440-66-6	
5000		103	130	70		20	7429-90-5	
500		106	130	70		20	7440-50-8	
5000		102	130	70		20	7439-89-6	
500		100	130	70		20	7439-92-1	
500		103	130	70		20	7439-96-5	
5000		109	130	70		20	7440-09-7	
500		102	130	70		20	7440-66-6	
5000		106	130	70	2	20	7429-90-5	
500		106	130	70	0	20	7440-50-8	
5000		104	130	70	2	20	7439-89-6	
500		100	130	70	0	20	7439-92-1	
500		103	130	70	0	20	7439-96-5	
5000		110	130	70	0	20	7440-09-7	
500		102	130	70	0	20	7440-66-6	
							7440-09-7	
							7440-09-7	
							7440-09-7	
							7440-09-7	
							7440-09-7	
							7440-09-7	
							7440-09-7	
							7429-90-5	

InternalWorkOrder	InternalID	LabCode	ClientName	SampleDate	LogTime	DateReceived	PrepDate	CountDate	AnaTime	Run	SampNo
30222947	30223055003	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:42		1
30222947	30223055003	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:42		1
30222947	30223055003	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:42		1
30222947	30223055003	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:42		1
30222947	30223055003	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:42		1
30222947	30223055003	PacG	Weston			6/29/2017	6/30/2017	7/3/2017	16:42		1
30222947	1300512	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:18		1
30222947	1300512	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:18		1
	30222775001	PacG	Weston	7/5/2017			7/5/2017	7/5/2017	19:00		1
	30222775001	PacG	Weston	7/5/2017			7/5/2017	7/5/2017	19:00		1
30222947	30222775001MS	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:20		1
30222947	30222775001MS	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:20		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/5/2017	7/5/2017	19:01		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/5/2017	7/5/2017	17:02		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/5/2017	7/5/2017	17:02		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/5/2017	7/6/2017	08:19		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/5/2017	7/6/2017	08:19		1
30222947	LCS36487	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:19		1
30222947	LCS36487	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:19		1
30222947	LCSD36487	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:19		1
30222947	LCSD36487	PacG	Weston	7/5/2017	09:40		7/5/2017	7/6/2017	08:19		1
30222947	1300369	PacG	Weston	7/5/2017	10:57		7/5/2017	7/14/2017	11:03		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/5/2017	7/14/2017	11:24		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/5/2017	7/14/2017	11:24		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/5/2017	7/14/2017	11:24		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/5/2017	7/14/2017	11:24		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/5/2017	7/14/2017	11:24		1

SBD	SED	Matrix	SampleType	AnalysisCode	ClientID	Isotope	Method	ReportUnits	Result	Uncertainty	RL
0	0	Water	REG		263861 PS 1299014	Copper	EPA 200.7	ug/L			5.0
0	0	Water	REG		263861 PS 1299014	Iron	EPA 200.7	ug/L	25300		70.0
0	0	Water	REG		263861 PS 1299014	Lead	EPA 200.7	ug/L			5.0
0	0	Water	REG		263861 PS 1299014	Manganese	EPA 200.7	ug/L	9110		5.0
0	0	Water	REG		263861 PS 1299014	Potassium	EPA 200.7	ug/L	5120		500
0	0	Water	REG		263861 PS 1299014	Zinc	EPA 200.7	ug/L	231		10.0
0	0	Water	BLANK	GA		Gross Alpha	EPA 900.0	pCi/L	0.690	0.857	1.79
0	0	Water	BLANK	GB		Gross Beta	EPA 900.0	pCi/L	1.39	1.14	2.31
0	0	Water	REG	GA		Gross Alpha	EPA 900.0	pCi/L	3.64	0.956	0.911
0	0	Water	REG	GB		Gross Beta	EPA 900.0	pCi/L	0.478	0.393	0.654
0	0	Water	MS	GA		Gross Alpha	EPA 900.0	pCi/L	59.1	12.1	2.29
0	0	Water	MS	GB		Gross Beta	EPA 900.0	pCi/L	47.9	9.32	2.02
0	0	Water	REG	GA	0428-WSW01-2	Gross Alpha	EPA 900.0	pCi/L	1.92	0.750	0.914
0	0	Water	REG	GB	0428-WSW01-2	Gross Beta	EPA 900.0	pCi/L	3.23	0.900	1.04
0	0	Water	REG	GA	0428-WSW02-2	Gross Alpha	EPA 900.0	pCi/L	0.994	0.441	0.610
0	0	Water	REG	GB	0428-WSW02-2	Gross Beta	EPA 900.0	pCi/L	2.76	0.664	0.640
0	0	Water	REG	GA	0428-WSW03-2	Gross Alpha	EPA 900.0	pCi/L	2.82	0.761	0.628
0	0	Water	REG	GB	0428-WSW03-2	Gross Beta	EPA 900.0	pCi/L	3.32	0.750	0.602
0	0	Water	REG	GA	0428-WSW04-2	Gross Alpha	EPA 900.0	pCi/L	3.63	0.972	0.919
0	0	Water	REG	GB	0428-WSW04-2	Gross Beta	EPA 900.0	pCi/L	3.59	0.801	0.624
0	0	Water	REG	GA	0428-WSW05-2	Gross Alpha	EPA 900.0	pCi/L	8.82	3.75	5.17
0	0	Water	REG	GB	0428-WSW05-2	Gross Beta	EPA 900.0	pCi/L	6.46	2.59	3.80
0	0	Water	REG	GA	0428-WSW06-2	Gross Alpha	EPA 900.0	pCi/L	0.723	0.402	0.618
0	0	Water	REG	GB	0428-WSW06-2	Gross Beta	EPA 900.0	pCi/L	3.21	0.718	0.568
0	0	Water	REG	GA	0428-WSW07-2	Gross Alpha	EPA 900.0	pCi/L	4.19	2.29	2.97
0	0	Water	REG	GB	0428-WSW07-2	Gross Beta	EPA 900.0	pCi/L	2.77	1.19	1.74
0	0	Water	LCS	GA		Gross Alpha	EPA 900.0	pCi/L	25.4	6.01	2.14
0	0	Water	LCS	GB		Gross Beta	EPA 900.0	pCi/L	21.9	4.63	1.71
0	0	Water	LCSD	GA		Gross Alpha	EPA 900.0	pCi/L	27.1	6.23	1.75
0	0	Water	LCSD	GB		Gross Beta	EPA 900.0	pCi/L	23.7	4.93	1.7
0	0	Water	BLANK	Ra226		Radium-226	EPA 903.1	pCi/L	0.272	0.204	0.105
0	0	Water	REG	Ra226	0428-WSW01-2	Radium-226	EPA 903.1	pCi/L	0.503	0.253	0.0853
0	0	Water	REG	Ra226	0428-WSW02-2	Radium-226	EPA 903.1	pCi/L	0.271	0.191	0.0919
0	0	Water	REG	Ra226	0428-WSW03-2	Radium-226	EPA 903.1	pCi/L	0.519	0.279	0.101
0	0	Water	REG	Ra226	0428-WSW04-2	Radium-226	EPA 903.1	pCi/L	0.677	0.331	0.108
0	0	Water	REG	Ra226	0428-WSW05-2	Radium-226	EPA 903.1	pCi/L	0.364	0.219	0.0897

MDA	Critical Level	LabQualifier	Batch	TracerKnown	TracerError	RadioPercentRec	GravPercentRec	TracerUpperLimit	TracerLowerLimit
5.0			ICP263781						
70.0			ICP263781						
5.0			ICP263781						
5.0			ICP263781						
500			ICP263781						
10.0			ICP263781						
1.79	0.558		RADC36487						
2.31	0.798		RADC36487						
0.911	0.392		RADC36487						
0.654	0.289		RADC36487						
2.29	0.702		RADC36487						
2.02	0.69		RADC36487						
0.914	0.377		RADC36487						
1.04	0.458		RADC36487						
0.610	0.256		RADC36487						
0.640	0.283		RADC36487						
0.628	0.261		RADC36487						
0.602	0.266		RADC36487						
0.919	0.393		RADC36487						
0.624	0.276		RADC36487						
5.17	2.19		RADC36487						
3.80	1.68		RADC36487						
0.618	0.261		RADC36487						
0.568	0.25		RADC36487						
2.97	0.88		RADC36487						
1.74	0.593		RADC36487						
2.14	0.639		RADC36487						
1.71	0.577		RADC36487						
1.75	0.506		RADC36487						
1.7	0.573		RADC36487						
0.105	0		RADC36481						
0.0853	0		RADC36481						
0.0919	0		RADC36481						
0.101	0		RADC36481						
0.108	0		RADC36481						
0.0897	0		RADC36481						

SpikeKnown	SpikeKnownError	SpikeRecovery	SpikeUpperLimit	SpikeLowerLimit	RPD_Value	RPDLimit	CAS	ValidationQualifier
							7440-50-8	
							7439-89-6	
							7439-92-1	
							7439-96-5	
							7440-09-7	
							7440-66-6	
							12587-46-1	
							12587-47-2	
							12587-46-1	
							12587-47-2	
61.5	1.11	90	135	55			12587-46-1	
39.2	1.22	121	130	79			12587-47-2	
							12587-46-1	J+
							12587-47-2	J+
							12587-46-1	J+
							12587-47-2	J+
							12587-46-1	J+
							12587-47-2	J+
							12587-46-1	J+
							12587-47-2	J+
							12587-46-1	J+
							12587-47-2	J+
							12587-46-1	J+
							12587-47-2	J+
							12587-46-1	J+
							12587-47-2	J+
30.9	0.555	82	121	69			12587-46-1	
19.7	0.61	111	130	79			12587-47-2	
30.1	0.543	90	121	69		34	12587-46-1	
19.2	0.595	123	130	79		29	12587-47-2	
							13982-63-3	
							13982-63-3	
							13982-63-3	UJ
							13982-63-3	
							13982-63-3	
							13982-63-3	

InternalWorkOrder	InternalID	LabCode	ClientName	SampleDate	LogTime	DateReceived	PrepDate	CountDate	AnaTime	Run	SampNo
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/5/2017	7/14/2017	11:24		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/5/2017	7/14/2017	11:38		1
30222947	30222947008	PacG	Weston	7/5/2017	10:57		7/5/2017	7/14/2017	11:38		1
30222947	30222947009	PacG	Weston	7/5/2017	10:57		7/5/2017	7/14/2017	11:38		1
30222947	LCS36481	PacG	Weston	7/5/2017	10:57		7/5/2017	7/14/2017	11:38		1
30222947	1302865	PacG	Weston	7/11/2017	07:08		7/11/2017	7/14/2017	11:58		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/11/2017	7/14/2017	12:12		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/11/2017	7/14/2017	11:28		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/11/2017	7/14/2017	11:28		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/11/2017	7/14/2017	11:28		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/11/2017	7/14/2017	11:28		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/11/2017	7/14/2017	11:28		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/11/2017	7/14/2017	11:28		1
30222947	30222947008	PacG	Weston	7/11/2017	07:08		7/11/2017	7/14/2017	11:28		1
30222947	30222947009	PacG	Weston	7/11/2017	07:08		7/11/2017	7/14/2017	11:28		1
	35321055001	PacG	Weston	7/11/2017			7/11/2017	7/14/2017	11:33		1
30222947	35321055001MS	PacG	Weston	7/11/2017	07:08		7/11/2017	7/14/2017	11:29		1
30222947	LCS36563	PacG	Weston	7/11/2017	07:08		7/11/2017	7/14/2017	11:29		1
30222947	1300731	PacG	Weston	7/5/2017	06:07		7/5/2017	7/5/2017	14:23		1
30222947	1300731	PacG	Weston	7/5/2017	06:07		7/5/2017	7/5/2017	14:23		1
30222947	1300731	PacG	Weston	7/5/2017	06:07		7/5/2017	7/5/2017	14:23		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/5/2017	7/5/2017	14:24		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/5/2017	7/5/2017	14:24		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	7/5/2017	7/5/2017	14:24		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/5/2017	7/5/2017	14:24		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/5/2017	7/5/2017	14:24		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	7/5/2017	7/5/2017	14:24		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	7/5/2017	7/6/2017	06:02		1

SBD	SED	Matrix	SampleType	AnalysisCode	ClientID	Isotope	Method	ReportUnits	Result	Uncertainty	RL
0	0	Water	REG	Ra226	0428-WSW06-2	Radium-226	EPA 903.1	pCi/L	0.815	0.369	0.110
0	0	Water	REG	Ra226	0428-WSW07-2	Radium-226	EPA 903.1	pCi/L	0.594	0.299	0.101
0	0	Water	MS	Ra226		Radium-226	EPA 903.1	pCi/L	19.2	2.71	0.0877
0	0	Water	MS	Ra226		Radium-226	EPA 903.1	pCi/L	19.7	2.81	0.0952
0	0	Water	LCS	Ra226		Radium-226	EPA 903.1	pCi/L	8.81	1.5	0.259
0	0	Water	BLANK	Ra228		Radium-228	EPA 904.0	pCi/L	0.525	0.414	0.819
0	0	Water	REG	Ra228	0428-WSW01-2	Radium-228	EPA 904.0	pCi/L	1.37	0.516	0.772
0	0	Water	REG	Ra228	0428-WSW02-2	Radium-228	EPA 904.0	pCi/L	0.475	0.336	0.647
0	0	Water	REG	Ra228	0428-WSW03-2	Radium-228	EPA 904.0	pCi/L	0.960	0.438	0.732
0	0	Water	REG	Ra228	0428-WSW04-2	Radium-228	EPA 904.0	pCi/L	1.42	0.503	0.723
0	0	Water	REG	Ra228	0428-WSW05-2	Radium-228	EPA 904.0	pCi/L	1.93	0.573	0.694
0	0	Water	REG	Ra228	0428-WSW06-2	Radium-228	EPA 904.0	pCi/L	0.0758	0.285	0.645
0	0	Water	REG	Ra228	0428-WSW07-2	Radium-228	EPA 904.0	pCi/L	0.535	0.396	0.774
0	0	Water	MS	Ra228		Radium-228	EPA 904.0	pCi/L	9.84	1.95	0.637
0	0	Water	MS	Ra228		Radium-228	EPA 904.0	pCi/L	9.79	1.94	0.667
0	0	Drinking Water	REG	Ra228		Radium-228	EPA 904.0	pCi/L	0.904	0.433	0.74
0	0	Water	MS	Ra228		Radium-228	EPA 904.0	pCi/L	9.58	1.88	0.536
0	0	Water	LCS	Ra228		Radium-228	EPA 904.0	pCi/L	5.37	1.15	0.602
0	0	Water	BLANK	U234		Uranium-234	HSL-300	pCi/L	-0.013	0.081	0.244
0	0	Water	BLANK	U235		Uranium-235	HSL-300	pCi/L	0.043	0.099	0.160
0	0	Water	BLANK	U238		Uranium-238	HSL-300	pCi/L	0.058	0.076	0.105
0	0	Water	REG	U234	0428-WSW01-2	Uranium-234	HSL-300	pCi/L	0.246	0.158	0.143
0	0	Water	REG	U235	0428-WSW01-2	Uranium-235	HSL-300	pCi/L	0.115	0.122	0.153
0	0	Water	REG	U238	0428-WSW01-2	Uranium-238	HSL-300	pCi/L	0.213	0.147	0.139
0	0	Water	REG	U234	0428-WSW02-2	Uranium-234	HSL-300	pCi/L	0.237	0.168	0.143
0	0	Water	REG	U235	0428-WSW02-2	Uranium-235	HSL-300	pCi/L	0.133	0.156	0.249
0	0	Water	REG	U238	0428-WSW02-2	Uranium-238	HSL-300	pCi/L	0.101	0.115	0.170
0	0	Water	REG	U234	0428-WSW03-2	Uranium-234	HSL-300	pCi/L	0.224	0.171	0.241
0	0	Water	REG	U235	0428-WSW03-2	Uranium-235	HSL-300	pCi/L	0.231	0.174	0.089
0	0	Water	REG	U238	0428-WSW03-2	Uranium-238	HSL-300	pCi/L	0.019	0.091	0.126
0	0	Water	REG	U234	0428-WSW04-2	Uranium-234	HSL-300	pCi/L	0.250	0.166	0.227
0	0	Water	REG	U235	0428-WSW04-2	Uranium-235	HSL-300	pCi/L	0.057	0.097	0.134
0	0	Water	REG	U238	0428-WSW04-2	Uranium-238	HSL-300	pCi/L	0.057	0.074	0.102
0	0	Water	REG	U234	0428-WSW05-2	Uranium-234	HSL-300	pCi/L	1.63	0.427	0.102
0	0	Water	REG	U235	0428-WSW05-2	Uranium-235	HSL-300	pCi/L	0.190	0.142	0.072
0	0	Water	REG	U238	0428-WSW05-2	Uranium-238	HSL-300	pCi/L	1.22	0.356	0.102

MDA	Critical Level	LabQualifier	Batch	TracerKnown	TracerError	RadioPercentRec	GravPercentRec	TracerUpperLimit	TracerLowerLimit
0.110	0		RADC36481						
0.101	0		RADC36481						
0.0877	0		RADC36481						
0.0952	0		RADC36481						
0.259	0.0823		RADC36481						
0.819	0.296		RADC36563						
0.772	0.278		RADC36563						
0.647	0.232		RADC36563						
0.732	0.264		RADC36563						
0.723	0.261		RADC36563						
0.694	0.25		RADC36563						
0.645	0.233		RADC36563						
0.774	0.28		RADC36563						
0.637	0.228		RADC36563						
0.667	0.24		RADC36563						
0.74	0.267		RADC36563						
0.536	0.191		RADC36563						
0.602	0.214		RADC36563						
0.244	0.0737		RADC36497	20.3		100		110	30
0.160	0.0337		RADC36497	20.3		100		110	30
0.105	0.019		RADC36497	20.3		100		110	30
0.143	0.0313		RADC36497	20.3		92		110	30
0.153	0.0276		RADC36497	20.3		92		110	30
0.139	0.0299		RADC36497	20.3		92		110	30
0.143	0.0258		RADC36497	20.3		92		110	30
0.249	0.0584		RADC36497	20.3		92		110	30
0.170	0.0365		RADC36497	20.3		92		110	30
0.241	0.0681		RADC36497	20.3		78		110	30
0.089	0		RADC36497	20.3		78		110	30
0.126	0.0227		RADC36497	20.3		78		110	30
0.227	0.0677		RADC36497	20.3		101		110	30
0.134	0.0241		RADC36497	20.3		101		110	30
0.102	0.0185		RADC36497	20.3		101		110	30
0.102	0.0184		RADC36497	20.3		103		110	30
0.072	0		RADC36497	20.3		103		110	30
0.102	0.0184		RADC36497	20.3		103		110	30

SpikeKnown	SpikeKnownError	SpikeRecovery	SpikeUpperLimit	SpikeLowerLimit	RPD_Value	RPDLimit	CAS	ValidationQualifier
							13982-63-3	J
							13982-63-3	
20	0.939	93	136	71			13982-63-3	
20.1	0.939	95	136	71	3	25	13982-63-3	
10	0.47	88	135	73			13982-63-3	
							15262-20-1	
							15262-20-1	
							15262-20-1	
							15262-20-1	
							15262-20-1	
							15262-20-1	
							15262-20-1	
							15262-20-1	
8.91	0.642	104	135	60			15262-20-1	
9.04	0.642	102	135	60	2	36	15262-20-1	
							15262-20-1	
9.05	0.642	96	135	60			15262-20-1	
5.92	0.427	91	135	60			15262-20-1	
							13966-29-5	
							15117-96-1	
							13966-29-5	
							15117-96-1	
							13966-29-5	J
							15117-96-1	
							13966-29-5	
							15117-96-1	
							13966-29-5	
							15117-96-1	
							13966-29-5	
							15117-96-1	
							13966-29-5	
							15117-96-1	

InternalWorkOrder	InternalID	LabCode	ClientName	SampleDate	LogTime	DateReceived	PrepDate	CountDate	AnaTime	Run	SampNo
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	7/5/2017	7/6/2017	06:02		1
30222947	30222947008	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	06:02		1
30222947	30222947008	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	06:02		1
30222947	30222947009	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	06:02		1
30222947	30222947009	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	06:02		1
30222947	LCS36497	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	10:04		1
30222947	LCS36497	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	10:04		1
30222947	LCSD36497	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	10:04		1
30222947	LCSD36497	PacG	Weston	7/5/2017	06:07		7/5/2017	7/6/2017	10:04		1
30222947	1297742	PacG	Weston	6/29/2017	00:00		6/29/2017	6/29/2017	16:55		1
30222947	30222864001DUP	PacG	Weston	6/29/2017	00:00		6/29/2017	6/30/2017	03:25		1
30222947	30222947001	PacG	Weston	6/27/2017	12:50	6/29/2017	6/29/2017	6/29/2017	20:57		1
30222947	30222947002	PacG	Weston	6/27/2017	12:45	6/29/2017	6/29/2017	6/29/2017	21:31		1
30222947	30222947002DUP	PacG	Weston	6/29/2017	00:00		6/29/2017	6/29/2017	22:04		1
30222947	30222947003	PacG	Weston	6/28/2017	10:05	6/29/2017	6/29/2017	6/29/2017	23:30		1
30222947	30222947004	PacG	Weston	6/28/2017	10:35	6/29/2017	6/29/2017	6/30/2017	00:03		1
30222947	30222947005	PacG	Weston	6/27/2017	10:05	6/29/2017	6/29/2017	6/30/2017	00:37		1
30222947	30222947006	PacG	Weston	6/27/2017	12:48	6/29/2017	6/29/2017	6/30/2017	01:10		1
30222947	30222947007	PacG	Weston	6/27/2017	11:40	6/29/2017	6/29/2017	6/30/2017	01:44		1
30222947	36449_15-009LCS1	PacG	Weston	6/29/2017	00:00		6/29/2017	6/29/2017	16:36		1
30222947	36449_15-009LCS2	PacG	Weston	6/29/2017	00:00		6/29/2017	6/29/2017	22:38		1
30222947	36449_15-009LCS4	PacG	Weston	6/29/2017	00:00		6/29/2017	6/30/2017	03:58		1

SBD	SED	Matrix	SampleType	AnalysisCode	ClientID	Isotope	Method	ReportUnits	Result	Uncertainty	RL
0	0	Water	REG	U234	0428-WSW06-2	Uranium-234	HSL-300	pCi/L	0.083	0.108	0.206
0	0	Water	REG	U235	0428-WSW06-2	Uranium-235	HSL-300	pCi/L	0.048	0.101	0.146
0	0	Water	REG	U238	0428-WSW06-2	Uranium-238	HSL-300	pCi/L	0.049	0.079	0.156
0	0	Water	REG	U234	0428-WSW07-2	Uranium-234	HSL-300	pCi/L	0.605	0.242	0.167
0	0	Water	REG	U235	0428-WSW07-2	Uranium-235	HSL-300	pCi/L	0.048	0.097	0.135
0	0	Water	REG	U238	0428-WSW07-2	Uranium-238	HSL-300	pCi/L	0.208	0.136	0.123
0	0	Water	MS	U234		Uranium-234	HSL-300	pCi/L	27.7	4.45	0.147
0	0	Water	MS	U238		Uranium-238	HSL-300	pCi/L	27.1	4.36	0.0798
0	0	Water	MS	U234		Uranium-234	HSL-300	pCi/L	26.8	4.22	0.236
0	0	Water	MS	U238		Uranium-238	HSL-300	pCi/L	26.9	4.23	0.164
0	0	Water	LCS	U234		Uranium-234	HSL-300	pCi/L	13.4	2.22	0.255
0	0	Water	LCS	U238		Uranium-238	HSL-300	pCi/L	14.2	2.33	0.11
0	0	Water	LCSD	U234		Uranium-234	HSL-300	pCi/L	13.8	2.33	0.242
0	0	Water	LCSD	U238		Uranium-238	HSL-300	pCi/L	13.5	2.28	0.127
0	0	Water	BLANK			Radon	SM7500RnB-07	pCi/L	-12.6	19.6	34.9
0	0	Water	DUP			Radon	SM7500RnB-07	pCi/L	-61.5	93.2	166
0	0	Water	REG		0428-WSW01-2	Radon	SM7500RnB-07	pCi/L	369.1	79.6	53.3
0	0	Water	REG		0428-WSW02-2	Radon	SM7500RnB-07	pCi/L	793	153	53.6
0	0	Water	DUP			Radon	SM7500RnB-07	pCi/L	826	158	53.8
0	0	Water	REG		0428-WSW03-2	Radon	SM7500RnB-07	pCi/L	1,491	274	46.3
0	0	Water	REG		0428-WSW04-2	Radon	SM7500RnB-07	pCi/L	1,108	206	46.3
0	0	Water	REG		0428-WSW05-2	Radon	SM7500RnB-07	pCi/L	1,675	309	56.0
0	0	Water	REG		0428-WSW06-2	Radon	SM7500RnB-07	pCi/L	772	149	55.1
0	0	Water	REG		0428-WSW07-2	Radon	SM7500RnB-07	pCi/L	1,949	358	55.8
0	0	Water	LCS			Radon	SM7500RnB-07	pCi/L	10800	1950	47.9
0	0	Water	LCS			Radon	SM7500RnB-07	pCi/L	11400	2040	49.1
0	0	Water	LCS			Radon	SM7500RnB-07	pCi/L	10800	1950	47.8

MDA	Critical Level	LabQualifier	Batch	TracerKnown	TracerError	RadioPercentRec	GravPercentRec	TracerUpperLimit	TracerLowerLimit
0.206	0.0582		RADC36497	20.3		94		110	30
0.146	0.0274		RADC36497	20.3		94		110	30
0.156	0.0388		RADC36497	20.3		94		110	30
0.167	0.0439		RADC36497	20.3		93		110	30
0.135	0.0244		RADC36497	20.3		93		110	30
0.123	0.0264		RADC36497	20.3		93		110	30
0.147	0.0265		RADC36497	20.3		66		110	30
0.0798	0		RADC36497	20.3		66		110	30
0.236	0.0667		RADC36497	20.3		84		110	30
0.164	0.0385		RADC36497	20.3		84		110	30
0.255	0.077		RADC36497	20.3		94		110	30
0.11	0.0199		RADC36497	20.3		94		110	30
0.242	0.0684		RADC36497	20.3		76		110	30
0.127	0.0229		RADC36497	20.3		76		110	30
34.9			RADC36449						
166			RADC36449						
53.3			RADC36449						
53.6			RADC36449						
53.8			RADC36449						
46.3			RADC36449						
46.3			RADC36449						
56.0			RADC36449						
55.1			RADC36449						
55.8			RADC36449						
47.9			RADC36449						
49.1			RADC36449						
47.8			RADC36449						

SpikeKnown	SpikeKnownError	SpikeRecovery	SpikeUpperLimit	SpikeLowerLimit	RPD_Value	RPDLimit	CAS	ValidationQualifier
							13966-29-5	UJ
							15117-96-1	
							13966-29-5	
							15117-96-1	
28.6	1.01	95	125	75			13966-29-5	
29.2	1.03	92	125	75				
27.6	0.974	95	125	75	0	25	13966-29-5	
28.2	0.994	95	125	75	3	25		
13.7	0.484	98	125	75			13966-29-5	
14	0.494	101	125	75				
14.2	0.5	97	125	75		25	13966-29-5	
14.5	0.51	93	125	75		25		
							10043-92-2	
					-262	0	10043-92-2	
							10043-92-2	
							10043-92-2	
					4	0	10043-92-2	
							10043-92-2	
							10043-92-2	
							10043-92-2	
							10043-92-2	
							10043-92-2	
11800	576	92	110	90			10043-92-2	
11800	576	97	110	90			10043-92-2	
11800	576	92	110	90			10043-92-2	